Gun River
Watershed Management Plan

Prepared for

Allegan Conservation District

by

Conservation District

fishbeck, thompson, carr & huber
engineers • scientists • architects

DEQ
Michigan's
Nonpoint Source
Program

February 2004

GUN RIVER

WATERSHED MANAGEMENT PLAN

MDEQ TRACKING CODE: #2000-0164

FEBRUARY 2004
PROJECT NO. G01339

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement (C9975474-01) to Allegan Conservation District, 2000-0164. The contents of the document do not necessary reflect the views and policies of the Environment Protection Agency, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

FISHBECK, THOMPSON, CARR & HUBER, INC. **Engineers • Scientists • Architects**
1515 Arboretum Drive, SE, Grand Rapids, MI 49546 Telephone: 616-575-3824

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF CHARTS

LIST OF TABLES

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

319 Clean Water Act, Section 319
ACD Allegan Conservation District
ACDC Allegan County Drain Commissioner
ACHD Allegan County Health Department

TABLE OF CONTENTS

ACRC	Allegan County Road Commission
AFT	American Farmland Trust
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CMI	State of Michigan's Clean Michigan Initiative
CPA	Conservation Priority Area
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSO	Combined Sewer Overflow
EBI	Environmental Benefits Index
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
FEMA	Federal Emergency Management Agency
FFA	Future Farmers of America
FPP	Farmland Protection Program
FSA	USDA Farm Service Agency
GIS	Geographic Information System
GLPA	Gun Lake Protection Association
GPS	Global Positioning System
I&E	Information and Education
LESA	Land Evaluation and Site Assessment
LIS	Land Information Services
MDA	Michigan Department of Agriculture
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MIRIS	Michigan Resource Information System
MSUE	Michigan State University Extension
MUCC	Michigan United Conservation Clubs
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	USDA Natural Resources Conservation Service
NWI	National Wetlands Inventory
PCB	Polychlorinated Biphenyls
RC&D	USDA Resource, Conservation, & Development
SCS	USDA Soil Conservation Service (now NRCS)
SESC	Soil Erosion and Sedimentation Control
SWQD	MDEQ Surface Water Quality Division
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WHIP	Wildlife Habitat Incentive Program
WMP	Watershed Management Plan
WQS	Water Quality Standards
WRP	Wetland Reserve Program

EXECUTIVE SUMMARY

The Gun River Watershed (Watershed) encompasses an area of 73,272 acres in Allegan and Barry Counties, Michigan. The Gun River flows from Gun Lake through agricultural land into the urbanizing area of Otsego Township, Allegan County, where it joins the Kalamazoo River.

A Natural Features Inventory was completed for the Watershed using information obtained from Michigan State University's Natural Features Inventory database, the Michigan Department of Environmental Quality (MDEQ), and the Michigan Department of Natural Resources (MDNR). The entire Watershed is located within the Michigan/Indiana Till Plains Ecoregion, which is characterized by irregular plains, oak-hickory and beech-maple forests, cropland and pastures, and gray-brown podzolic soils. The Watershed is a diverse area containing a variety of plant communities and land uses. The Watershed has been significantly altered from its presettlement conditions, primarily due to agricultural development. Many of the Watershed forests have been cleared and the wetlands drained. The Yankee Springs State Recreation Area contains relatively undisturbed natural areas, which have documented densities of endangered, threatened, and special concern plant and animal species.

The Gun River and its tributaries are impaired by nonpoint source (NPS) pollution. Previous studies have identified pathogens, phosphorus, polychlorinated biphenyls's (PCBs), mercury, nutrients, and poor macroinvertebrate communities as degrading the water quality in certain waterbodies within the Watershed. Other significant water quality impairments include degraded indigenous aquatic habitat, a decline of biotic diversity, and reduced fish populations caused by sedimentation and excessive nutrients.

Best Management Practices (BMPs) to address NPS pollutants present in the Watershed have been identified and quantified to estimate costs of reducing impairments in the Watershed. Estimates of the desired load reductions to meet water quality standards have been determined in designated areas and all significant water quality problems have been addressed. A schedule for implementing the BMPs was developed. The following goals have been developed for the Watershed:

- Reduce soil erosion and sedimentation by 10% of the sediment loadings per year.
- Reduce nutrients by 10% of the phosphorus loading, 5% of the nitrogen loading, and establish a Total Maximum Daily Load (TMDL) in designated areas.
- Stabilize stream flows to moderate hydrology and increase base flows.
- Manage obstructions.
- Prevent *E. coli* from entering surface waters and attain water quality standards for Total Body Contact Recreation from May 1 to October 1 in Gun Lake.
- Maintain the coldwater fishery.

- Reduce the potential for hydrocarbon contamination.
- Minimize the spread of invasive and exotic species.
- Minimize fragmentation of habitat.

Hydrologic and hydraulic analyses were performed for the Gun River in Allegan and Barry Counties as an additional study component of the Gun River Watershed Management Plan (WMP). An understanding of the hydrologic and hydraulic characteristics of the Watershed is consistent with the goal of reducing NPS pollution. Conclusions from the Hydrologic and Hydraulic (H&H) Analysis of the Gun River are summarized as follows:

- Overall, the Gun River appears to be relatively stable due to the "non-flashy" nature of the Watershed.

- The hydrology of the Watershed is such that development upstream of Gun Lake will have minimal impact on the Gun River due to the large amount of storage available in Gun Lake. Low, broad hydrographs are characteristic of the discharge from Gun Lake (i.e., the upper watershed).

- The most significant contribution to the Gun River downstream of Gun Lake is via three major tributaries that enter at about midpoint along the Gun River. The large contribution of discharge from Greggs Brook Drain, Orangeville Drain, and Fenner Creek will actually cause reverse flow in the upper portion of the Gun River during flood events. However, the land use trend over the last 40 years (as indicated on land cover maps) has been from intense agricultural use toward more fallow and open space, which would tend to result in lower runoff rates and volumes.

- A storm water detention policy release rate restriction of 0.06 cfs per acre was determined to keep the post development flow and water surface elevation at the same levels as predevelopment for a 25-year flooding event.

- Storm water runoff criteria that control larger flood event (25-year storm) are not effective for controlling smaller channel forming flows (2-year storm). Therefore, separate design criteria are needed to protect the tributary streams form new developments.

- The most significant changes in land use between existing zoning and future land use plans are in the lower portion of the Watershed in Otsego and Gun Plain Townships. However, urban sprawl is occurring throughout the Watershed regardless of current zoning that indicates an agricultural use.

- The only structures that would be expected to overtop during the 100-year flood are the approaches to the bridges at 9th Street and 106th Avenue. However, it is apparent from the water surface profiles that the culverts at 116th and 118th Avenues cause the greatest rise in water surface elevations and directly impact the predicted elevation of the floodplain upstream.

A Community Outreach Plan was developed to guide activities and focus appropriate attention on issues that pertain to the Watershed. The activities enhanced public understanding of the project and encouraged the early and continued participation in selecting, designing, and implementing the BMPs and policies. The goals for the Community Outreach Plan are:

- To build and retain high levels of stakeholder awareness and involvement in the Watershed so that community values related to stewardship for the Gun River can be sustained.

- To promote ongoing participation of watershed residents in activities that benefit the Watershed and water quality.

- To build awareness of Watershed residents' responsibilities of how their individual actions and activities affect water quality.

All of these recommendations will work toward restoring the designated uses of agriculture, navigation, warmwater fishery, coldwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and total body contact recreation.

The evaluation of the results of the Watershed project will assess the methods and strategies of the implementation of the WMP and its effect on water quality. Interim, measurable milestones for determining whether the BMPs and other controls are being implemented are described. A set of criteria that can be used to determine whether loading reductions are being achieved over time and progress is being made toward attaining water quality standards was developed. A set of criteria was also developed to determined whether this WMP needs to be revised if the BMPs are not making progress toward meeting water quality standards. Included in the evaluation of the project is a monitoring component to evaluate the effectiveness of the implementation efforts over time, using the previously established criteria.

Sustainability of the goals of the Watershed project depends on the coordination of the numerous programs and efforts of other groups and organizations associated with the Watershed. The high level of involvement in the Kalamazoo River Watershed Remedial Action Plan and the Kalamazoo River TMDL provides an indication of the high possibility of long-term sustainability of the Watershed project.

The WMP is the result of a NPS pollution grant under the U.S. Environmental Protection Agency's (EPA) Clean Water Act Section 319 initiative, in coordination with the MDEQ. The Watershed exhibits unique hydrologic problems in addition to water quality, habitat, and soil erosion issues. The primary purpose of this WMP is to improve cooperation between residents and local and state agencies in an effort to protect, restore, and enhance the natural resources of the Watershed, the Kalamazoo River Watershed, and ultimately, Lake Michigan.

CHAPTER 1 - WATERSHED DESCRIPTION

1.0 OVERVIEW

The Gun River Watershed (Watershed) covers an area of 73,272 acres in Allegan and Barry Counties, Michigan (Figure 1). The Gun River, formed by the outflow of Gun Lake, flows south through agricultural and urbanizing areas before entering the Kalamazoo River in Otsego Township (Figure 2).

The Watershed is contained within the Michigan/Indiana Till Plains Ecoregion. The characteristics of this particular ecoregion include cropland, pasture, woodlands, and forest. Irregular plains with a mix of relatively level lands and rolling hills and valleys are vegetated with oak, hickory, beech, and maple. Soils are predominately gray-brown, podzolic (Kalamazoo River Watershed Council, 1998).

1.1 GEOGRAPHIC SCOPE

The Watershed encompasses portions of Wayland, Martin, Gun Plain, and Otsego Townships in Allegan County, and portions of Thornapple, Yankee Springs, Orangeville, and Prairieville Townships in Barry County. The eastern half of the Village of Martin and the northeast section of the City of Plainwell (both within Allegan County) are also within the Watershed (Figure 2).

The majority of Gun Lake lies in Barry County. The distance between the outlet at Gun Lake and the mouth of the Gun River where it enters the Kalamazoo River is about 12 miles.

1.2 TOPOGRAPHY

The formation of the Kalamazoo River Basin (Basin) was mostly influenced by glacial movement. The glaciers' retreat deposited drift that forms the hills, valleys, rivers, and streams of the Basin. Soil erosion and human manipulation of the land has changed the landscape in recent history, but glacial drift extends to a depth of 400 feet in the Watershed. Rolling landscapes, gently rolling plains, wetlands, and open water are glacial features that are present in the eastern portion of the Watershed (USDA, SCS, 1987).

The elevation ranges from 893 feet above see level at the northeastern boundary of the Watershed, to 671 feet above sea level at its mouth in Otsego Township (Figure 3). The land in the western portion of the Watershed is nearly level or slightly undulating, and is mostly well to excessively drained. Runoff varies with the degree of slope, which reaches 40% in the eastern portion of the Watershed (Duffy, 1991).

According to the Lake Allegan/Kalamazoo River TMDL study (2000), the upper portion of the Watershed has an average slope of 3.4%, the middle portion of the Watershed is slightly steeper with a 3.7% average slope, and the lower portion has an average slope of 3.1%.

1.3 SOILS

The soils that predominate the Gun River floodplain are of the Glendora-Adrian-Granby association, nearly level, poorly drained, and very poorly drained soils formed in the sandy and organic material. These soils are typical in the floodplain, outwash plains, and till plains of this area.

The soils in the western portion of the Watershed are predominantly fine sands, sandy loams, and loamy sands of the Chelsea-Ockley-Oshtemo association, generally poorly drained with slow surface runoff.

Sands, loamy sands, and muck soils are present in the eastern portion of the Watershed, resulting in poor drainage in the Houghton and Adrian muck soils to well to excessive drainage in the Coloma, Boyer, and Spinks loamy sand complexes. Residential development has disturbed much of the natural soils through cutting and filling. Building site development in most of the Watershed is rated as fair to poor, based on the high water table and the susceptibility of erosion in these soils (United States Department of Agriculture (USDA), SCS, Barry County, 1990).

The majority of the soils in the Watershed are well suited to agriculture, capable of producing adequate yields of corn and soybeans. The major crops in the Watershed are corn, soybeans, wheat, oats, and alfalfa.

Total acres and percent of area represented for each hydrologic soil group in the Watershed are shown in Table 1.1. The majority of the Watershed has high to moderate infiltration rates with high to moderate transmission rates. Much of the land area has low runoff potential (Figure 4).

Table 1.1 - Hydrologic Soil Groups in the Gun River Watershed (USDA-SCS, 1987; USDA-SCS, 1990)

Hydrologic Soil Group	Acres in Allegan County	Acres in Barry County	Total Acres in Watershed	Percent in Watershed
A	11,361	14,852	26,214	36%
A/D	8,778	4,425	13,203	18%
B	16,147	6,319	22,466	31%
B/D	2,775	136	2,910	4%
C	1,971	234	2,204	3%
C/D	36	0	36	<1%
D	589	5,650	6,239	8%
TOTAL	41,615	31,657	73,272	100%

A - High infiltration rate, low runoff potential. Well drained to excessively drained sands or gravely sands. High rate of water transmission.

B - Moderate infiltration rate. Moderately well to well drained. Moderately fine to medium coarse texture. Moderate rate of water transmission.

C - Slow infiltration rate. Has layer that impedes downward movement of water. Moderately fine to fine texture. Slow rate of water transmission.

D - Very slow infiltration rate, high runoff potential. Clays with high shrink/swell potential. Permanent high water table. Clay pan or clay layer at or near surface. Shallow over nearly impervious material. Very slow rate of water transmission.

/ = if drained/if natural.

1.4 CLIMATE

The climate of an area is a representation of the general weather conditions over a long period of time. The Watershed experiences a typical Great Lakes area climate, much of which is influenced by “lake effect.” For this area, average annual precipitation is about 32 inches and average snowfall often approaches 100 inches. The average temperature for the area in July is 72°F and 24°F in January. The annual mean temperature is 49°F for the area. Allegan County records state that average daily temperature in the area is 48.3°F. The average growing season is approximately 168 days (Kalamazoo River Watershed Council, 1998).

Rainfall measured from the Kriged seasonal data, from April 1, 1998, to September 30, 1998, was in the range of 17.3 inches to 19 inches (Kalamazoo River/Lake Allegan TMDL, 2000). Rainfall measured from the Kriged average annual precipitation data, from 1950 to 1999, ranged from 31.1 inches to 32.7 inches. The nearest weather station is located at Gull Lake, Kalamazoo County.

1.5 LAND USE

Agriculture is the predominant land use in the Watershed, however large portions of land in the eastern part of the Watershed are included in the Barry State Game Area and the Yankee Springs Recreation Area, which are, and will remain, as woodlands (Figure 5).

The land use around Gun Lake is mostly residential. The northeast shore in the east basin is a marshy area that has remained undeveloped.

The lower portion of the Watershed is estimated to have an average of 5% to 10% impervious cover, mostly adjacent to the City of Otsego. The rest of the Watershed is estimated to have an average of 0% to 5% impervious cover.

The agricultural production in the area includes corn, soybeans, wheat, and oats. A large amount of farmland is also used for pasturing and growing alfalfa. Apple orchards are scattered throughout the Watershed. Farms raising cattle, for dairy and beef, and hogs are in the Watershed, as well as a few poultry farms (Kalamazoo River Watershed Council, 1998).

Every township in the Watershed has different zoning ordinances, however, similarities do exist in the types of zones and land use distribution. Light industrial sites are present in the Watershed even though no areas are currently zoned for this land use. Agricultural zones contain the majority of homes in the Watershed, and are classified as rural residential. Very few commercial zones have been defined at this time.

The only major road is US-131, which traverses the western edge of Gun Plain Township in the southwest section of the Watershed. Patterson Road is the boundary between Allegan and Barry Counties. Marsh Road runs parallel to the Gun River on the south side for much of its length. Paved east-west arterial roads include 112th Avenue and 124th Avenue.

The MDNR controls about 4 miles of the Gun Lake shoreline. The MDNR operates a park on the peninsula dividing the two lake basins and provides visitors with excellent recreational opportunities such as camping areas, boat launches, and a day use area. A public boat launch and access area is also operated by the Allegan County Parks Department on the west basin. Boat rentals, through private resorts, operate throughout the summer months to give even more recreation options to the lake users. The adjacent Yankee Springs Recreation Area provides overnight camping and day use facilities on 1,000 acres within the Watershed (Duffy, 1991).

1.6 HYDROLOGY

Hydrology is the study of the distribution and movement of water both above and below the surface of a land area. The flow regime and hydrology of the Gun River are explained in more detail in Chapter 4.

1.6.1 LAKES

Gun Lake is the largest lake in the Watershed, located in the southwest corner of Yankee Springs Township and the northwest corner of Orangeville Township in Barry County. Covering more than 4 square miles, approximately 2,680 acres, Gun Lake is a popular recreation destination of residents in West Michigan. The lake is situated about 10 miles west of Hastings, 30 miles southeast of Grand Rapids, and 30 miles northeast of Kalamazoo. The Lake has 17.8 miles of shoreline, with an additional 1.4 miles of island shoreline. Payne Lake, Long Lake, Hall Lake, Fawn Lake, and numerous small lakes and ponds drain into Gun Lake. The outlet of Gun Lake is the Gun River.

The east and west basin of the lake have very different characteristics. The east basin has a marl bottom, with a few small areas of peat. The maximum depth is 68 feet. Some areas have gravel present and many of the submerged and emergent islands are surrounded by gravel bars and boulders. Areas of the shoreline are very steep, and many bulkheads and seawalls along the shoreline were built in the early years of development. Brush shelters were installed in the early 1950s to provide additional fisheries habitat. The west portion of the lake is shallow, with a maximum depth of only 5 feet. The bottom is marl and the shorelines are mostly sandy. Historically, this shoreline was wooded, but development of the majority of the shoreline has significantly altered the vegetation, including the elimination of most of the submerged and emergent vegetation (Duffy, 1991).

Good water quality has always been the attraction to Gun Lake for users from around the State of Michigan. Water quality suffered in the past from bacterial contamination, but has vastly improved after the installation of a sewer system in 1980 that services the Gun Lake community. Testing for dissolved oxygen, temperature, pH, and alkalinity was completed in 1968 and 1989. A more detailed description of the water quality analysis can be found in Chapter 4.

1.6.2 IMPOUNDMENTS

A dam just north of Patterson Road, built in 1905, maintains the lake levels. Recreational demands resulted in higher than natural water levels. Before the construction of the dam, the lake was able to contain and store storm water runoff. Consistently high artificial lake levels do not allow the lake to store much rain water, therefore all of the runoff is released as it enters the lake, resulting in increased flooding downstream.

1.6.3 RIVERS, STREAMS, AND COUNTY DRAINS

The Gun River is approximately 12 miles long, originating from Gun Lake and flowing into the Kalamazoo River in Otsego Township. The geological characteristics of the Watershed include many low lying areas of wetlands and bogs. Many small- and medium-sized lakes are scattered throughout the Watershed as remnants of its previously swampy conditions. Most of the drainage was created by settlers to the area in the early 1900s. Tributaries to the Gun River constructed through county drainage projects include Gregg Brooks Drain, Fenner Lake Drain, and Orangeville Drain. Approximately 162 miles of streams are located in the Watershed. Gun River is a designated county drain and was straightened, widened, and deepened in 1903 to increase the drainage of the area and expose the rich, organic soil for farming. The historical meanders were mapped from old plat books, and more recently, aerial photographs. Changes in the location of the Gun River are illustrated in Figure 6.

1.6.4 GROUNDWATER

Water flowing under the surface of the land, between spaces in soils, clay deposits, sand, and gravel is called groundwater. The movement of groundwater is often toward surface water. Groundwater recharges rivers, lakes, and streams with the cold, filtered water on which they often depend to maintain flow.

The water table throughout most of the Watershed is very shallow and perched aquifers are common. The shallow water table maintains the Gun River's base flow, but also makes it necessary to drain soils before construction or agriculture may be pursued.

1.6.5 WETLANDS

The Gun River, in pre-settlement conditions, meandered through thousands of acres of wetlands before emptying into the Kalamazoo River. Today only a fraction of these wetlands remain. Nearly all of the wetland floodplain has been drained to expose the rich organic soils that are a basis for the economy of the Watershed. Pre-settlement vegetation is illustrated in Figure 7.

The conversion of wetlands to other land uses, especially in the Gun River floodplain, has dramatically affected drainage patterns in the Watershed. The result has been flashy stream flows, flooding, and a general loss of wildlife habitat. Many of the wetland areas that were drained could be restored by simply breaking drain tiles or plugging ditches.

CHAPTER 2 - NATURAL FEATURES INVENTORY

2.0 INTRODUCTION

A Natural Feature Inventory (NFI) is an important tool in planning for watershed development. It identifies areas within a watershed with unique or rare features that warrant protection and preservation. An accurate understanding of land use within a watershed will identify corridors or links between habitats and allows planning that minimizes fragmentation of these communities. Intelligent land use planning requires comprehensive knowledge of the natural features present within a watershed.

2.1 DESCRIPTION OF THE GUN RIVER WATERSHED

The entire Gun River Watershed (Watershed) is located within the Michigan/Indiana Till Plains Ecoregion. Characteristics of this region include irregular plains (a mixture of relatively level lands and rolling hills and valleys); oak, hickory, beech, and maple forests; cropland and pastures; and gray-brown podzolic soils. The topography of the Watershed has been primarily influenced by glacial activity. The Watershed once contained a great swamp that has been heavily drained and is now mainly used for row crops.

According to *The Kalamazoo River: Beauty and the Beast* (1998), six major types of native plant communities can be found within the Kalamazoo River Watershed:

Dry southern hardwood forest	Forests of dry upland sites with burr oak, black oak, or white ash dominating.
Moist southern hardwood forest	Forests that occur in moist soils and are dominated by beech and sugar maple.
Wet lowland forest	Forests characterized by willow and cottonwood, or silver maple and ash.
Grassland-savanna complex	Includes the combination of prairies, sedge meadows and savannas, characterized as treeless or with scattered trees and dominated by grasses or sedges, either wet or dry.
Marshes and emergent aquatic communities	Treeless areas in which the water table is above the soil surface during most of the growing season.

Submerged aquatic communities	Essentially lakes and ponds; the dominant plant species in these communities are below or on the water surface.

2.2 METHOD OF STUDY

Information regarding the plant and animal communities within the Watershed was obtained from various sources, including Michigan State University's (MSU) NFI database, the Michigan Department of Environmental Quality (MDEQ), and the Michigan Department of Natural Resources (MDNR).

2.3 UNIQUE NATURAL FEATURES

MSU's NFI maintains a database of known occurrences of endangered, threatened, and special concern plant and animal species throughout Michigan. An endangered species is any species that is in danger of extinction throughout all or a significant part of its range. A threatened species is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected under Michigan's Endangered Species Act (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act).

Special concern species are not protected under the Endangered Species Act. These species are of concern due to declining or relict populations in the state. If these species continue to decline, they would be recommended for threatened or endangered status. The maintenance of self-sustaining populations of special concern species is important in order to prevent the species from becoming endangered or threatened in the future.

The overall frequency of an Element Occurrence (EO) throughout the Watershed is noted in Figure 8. An EO is the physical piece of ground or water where an endangered, threatened, or a special concern plant or animal species is known to occur. One to five EOs are noted in most sections throughout the Watershed. Six to ten EOs are documented on the east side of Gun Lake, in the Yankee Springs State Recreation Area. Eleven to fifteen EOs are noted in the vicinity of Fish Lake and at the eastern end of the Watershed, north of 124th Avenue.

Table 2.1 lists the endangered, threatened, and special concern plant and animal species that have been observed within the Watershed. Each line of the table corresponds to one location where a species was observed.

Table 2.1 – Natural Features Present Within the Gun River Watershed

Scientific Name	Common Name	Status	First Observations	Last Observed	Category
RALLUS ELEGANS	KING RAIL	E	1949	1949-12-04	Animal
CLEMMYS GUTTATA	SPOTTED TURTLE	T	1991	1991-05-01	Animal
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1996-05-02	1996-06-02	Animal
FONTIGENS NICKLINIANA	WATERCRESS SNAIL	SC	1996	1996-05-13	Animal
SISTRURUS CATENATUS ATENATUS	EASTERN MASSASAUGA	SC	1960	2000-17-11	Animal
NOTROPIS ANOGENUS	PUGNOSE SHINER	SC	1946	1946-08-29	Animal
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1995	1995-07-01	Animal
ACRIS CREPITANS BLANCHARDI	BLANCHARD'S CRICKET FROG	SC	1952	1952-05-15	Animal
BOUTELOUA CURTIPENDULA	SIDE-OATS GRAMA GRASS	T	1969	1980-08-19	Plant
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1996	1996-07-16	Animal
ACRIS CREPITANS BLANCHARDI	BLANCHARD'S CRICKET FROG	SC	1986	1997-07-15	Animal
POTAMOGETON PULCHER	SPOTTED PONDWEED	T	1979	1985-08-01	Plant
KUHNIA EUPATORIOIDES	FALSE BONESET	SC	1949	1964-08-19	Plant
DRABA REPTANS	CREEPING WHITLOW-GRASS	T	1986	1989-06-09	Plant
AGRIMONIA ROSTELLATA	BEAKED AGRIMONY	SC	1971	1971	Plant
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1995	1995-06-26	Animal
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1989	1989-05	Animal
INCISALIA HENRICI	HENRY'S ELFIN	SC		1987	Animal
HEMILEUCA MAIA	BARRENS BUCKMOTH	SC	1968	1996-05-13	Animal
HELIANTHUS HIRSUTUS	WHISKERED SUNFLOWER	SC	1960	1960-07-21	Plant
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1995	1996-09-29	Animal
RALLUS ELEGANS	KING RAIL	E	1974	1983	Animal
CIRCUS CYANEUS	NORTHERN HARRIER	SC			Animal
CACALIA PLANTAGINEA	PRAIRIE INDIAN-PLANTAIN	SC	1965	1981-08-01	Plant
SCUTELLARIA PARVULA	SMALL SKULLCAP	T	1986	1986-06-17	Plant
MORAINE	GEOGRAPHICAL FEATURE				Other
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	1992	1994-09-15	Animal
HILLSIDE PRAIRIE	HIGH PRAIRIE, MIDWEST TYPE		1980	1981-08-18	Community
ACRIS CREPITANS BLANCHARDI	BLANCHARD'S CRICKET FROG	SC	1986	1992-05-20	Animal
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC			Animal
BESSEYA BULLII	KITTEN-TAILS	T	1980	1991-05-29	Plant
CLEMMYS GUTTATA	SPOTTED TURTLE	T	1968	1968-05-25	Animal
ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKYWING	T	1968	1971	Animal
OECANTHUS LARICIS	TAMARACK TREE CRICKET	SC	2000	2000-08-21	Animal
PRAIRIE FEN	ALKALINE SHRUB/HERB FEN, MIDWEST TYPE		2000-06-09	2000-07-05	Community
TERRAPENE CAROLINA CAROLINA	EASTERN BOX TURTLE	SC	2000-06-09	2000-06-09	Animal
CACALIA PLANTAGINEA	PRAIRIE INDIAN-PLANTAIN	SC	2000-07-05	2000-07-05	Plant
CACALIA PLANTAGINEA	PRAIRIE INDIAN-PLANTAIN	SC	1997-05-23	1997-05-23	Plant
PAPAIPEMA SPECIOSISSIMA	REGAL FERN BORER	SC	2000-09-25	2000-09-25	Animal

E = Endangered (legally protected)
T = Threatened (legally protected)
SC = Special Concern (rare or status uncertain; not legally protected)
Source: Michigan State University's Natural Features Inventory Database

The king rail is the only endangered animal that has been noted within the Watershed by the NFI, having been observed at two locations. The king rail is a large, slender marsh bird with a long bill and long toes. King rails arrive at Michigan marshes in mid-April, with pairs often returning to the same marsh in consecutive years. They exhibit secretive behavior, but are often heard at night during courtship and the incubation period (generally mid-April to mid-May). Nests are constructed in a clump or tussock above water level and generally have a canopy and entrance ramp. King rail populations have declined alarmingly in the past 30 years throughout major portions of its range. The decline is attributed to wetland destruction and degradation and to high pesticide residues.

Two threatened animal species have been observed within the Watershed: spotted turtle (observed at two locations) and Persius duskywing (a butterfly observed at one location). The spotted turtle is 3.5 to 5.4 inches long when an adult and is easily identified by the round yellow spots on its broad, smooth, black or brownish black carapace. It requires clean, shallow, slow-moving bodies of water with muddy or mucky bottoms and some aquatic and emergent vegetation. Spotted turtles primarily feed underwater, but are also frequently found on land during mating and nesting seasons and during the summer. The primary threats to this species are habitat destruction or degradation and illegal collection for the pet trade.

Table 2.1 also notes that ten special concern animal species have been observed within the Watershed. Most of these species, which includes insects, were only observed at one location. Two exceptions are the eastern box turtle, which was observed at nine locations, and Blanchard's cricket frog, which was observed at three locations.

According to the NFI, no endangered plant species have been observed within the Watershed. Five threatened plant species have been encountered at single locations in the Watershed; four are prairie and savanna species and one is an aquatic species. Additionally, four special concern plant species have been observed in the Watershed. Prairie indian plantain was observed at three locations, while the other special concern species were only observed at one location.

The NFI also noted the presence of two unique ecological communities within the Watershed. A prairie fen is located adjacent to Horseshoe Lake, east of Fish Lake in Orangeville Township, Barry County. The fen is located within the Yankee Springs State Recreation Area, and is therefore protected. Prairie fens are geologically and biologically unique wetlands found only in the glaciated Midwest. Saturated peat in the fen is maintained by a constant inflow of groundwater rich in calcium and magnesium from surrounding glacial deposits. Groundwater often upwells through the peat and forms broad seeps or local springs. The prairie fen is distinguished from other calcareous fens by tall grass prairie species.

The second unique ecological community present within the Watershed is a Midwest type high prairie. The prairie is located at the northern end of the Watershed in Thornapple Township, Barry County.

2.4 BIOLOGICAL SURVEYS

Several biological surveys have been completed by the MDEQ and MDNR within the Watershed. Summaries of the surveys are presented below.

1. *A Biological Survey of the Kalamazoo River and Selected Tributaries, June to September 1999* (MDEQ Surface Water Quality Division, November 2000).

This survey contains information specific to the Gun River. The report noted that macroinvertebrate sampling and habitat evaluations were conducted at seven locations within the Watershed. Table 2.2 summarizes the sampling locations and the results of the survey.

Table 2.2 - Biological Sampling Locations in the Gun River Watershed

Sampling Location	Habitat Evaluation	Macroinvertebrate Community Rating
Lake Sixteen Outlet at 6th Street	None	Acceptable
Greggs Brook Drain at 122nd Avenue	None	Acceptable
Gun Lake Outlet at 122nd Avenue	Poor, severely impaired	Poor
Orangeville Creek at Saddler Road	Good, slightly impaired	Acceptable
Fenner Creek at 2nd Street	Poor, severely impaired	Poor
Gun River at 7th Street	Fair, moderately impaired	Acceptable
Gun River at 110th Avenue	Fair, moderately impaired	Acceptable

The Gun Lake outlet and the Fenner Creek locations were impaired due to channel manipulation to support agricultural drainage. The lack of hard substrate materials and sedimentation and/or embedded substrates were the most common detriments to habitat scores.

2. *A Biological Survey of Gun River, Allegan County, Michigan* (MDNR Surface Water Quality Division Staff Report, December 1990).

The MDNR completed a biological survey of the Gun River in July 1989. The objective of the survey was to document the physical, chemical, and biological effects of the Gun Lake wastewater treatment plant discharge and nonpoint source runoff to the Gun River. This data was compiled and compared to previous surveys to evaluate the effects pollution has on the Watershed. Qualitative macroinvertebrate sampling and surface water sampling were conducted at five locations along the Gun River between Patterson Road and 10th Street. The results of the survey were compared to surveys conducted in 1977 and 1979. The report concluded that water chemistry was good in Gun River, with little change since 1980. Water chemistry was similar to that found in other suitable trout waters in Michigan.

The concentration of metals in sediment was slightly elevated at sampling locations downstream of Gun Lake. The metal concentrations had increased from levels measured in an earlier survey. The Gun Lake wastewater treatment plant may be releasing water with metals that have come from sources within their service district.

Macroinvertebrate communities have declined since 1980 in the lower reaches of Gun River. The report noted that high water levels in 1986 eroded streambanks. It is likely that the eroded soil was deposited downstream, causing the decline in the macroinvertebrate communities.

3. *Status of the Fishery Resource Report 91-2: Gun Lake* (Duffy, 1991).

This report describes the physical characteristics of Gun Lake and summarizes the results of fish surveys conducted from 1945 through 1989. The report indicates that the lake is separated into an east and a west basin which differ significantly in depth and structure. The west basin is almost uniformly shallow, with a maximum depth of 5 feet. Robbins Bay and Pickerel Cove, however, have maximum depths of 34 and 25 feet, respectively. The west basin has a marl bottom with sandy shorelines.

The east basin has variable depths that extend up to 68 feet. It has a marl bottom with a few small areas of peat and some gravel. This basin contains numerous submerged and emergent islands which are surrounded by gravel bars and boulders.

The report indicates that water quality in the lake is good. A sewage treatment plant, operated by the Gun Lake Sewer Authority, serves all the residences and businesses around the lake. The treatment plant was constructed in 1980. Most of the lakeshore is developed, with the exception of the marshy northeast shore in the east basin and the land included in Yankee Springs State Recreation Area.

Early records indicate that there were native populations of both muskellunge and walleye in Gun Lake. A lake mapping crew noted in 1945 that they had seen pictures of record catches of walleye, pike, bass, and muskellunge. The crew also reported seeing perch, bluegill, pike, muskellunge, largemouth and smallmouth bass, and sunfish in anglers' creels. Between 1921 and 1954, the lake was stocked yearly with all or some of the following species: largemouth bass, smallmouth bass, bluegill, walleye, and yellow perch. During this time period, the following species were also occasionally stocked: rainbow trout, fathead minnow, emerald shiner, and sunfish. The lake was stocked with walleye yearly from 1973 through 1989, and with northern muskellunge in 1977 and from 1979 through 1983.

The status report stated that the fish populations were essentially the same in 1989 as they were in the 1940s. Twenty-three different species of fish were identified during a lake survey conducted in 1989. The most prevalent species by total number and weight were largemouth bass, bluegill, and black crappie. The report indicated that Gun Lake supports a good fishable population of walleye. The northern muskellunge population has declined to a fraction of what existed prior to 1983, when stocking ceased. The northern pike population, however, increased in the 1980s, resulting in a good fishery at Gun Lake.

Smallmouth and largemouth bass are very popular sport fish in Gun Lake. The average largemouth bass collected in surveys has been between 7.3 and 11.8 inches long, with individuals up to 19 inches long. Smallmouth bass have averaged between 5.9 to 10.8 inches in surveys, and individuals up to 20 inches have been taken.

The report indicated that the yellow perch population did not appear to have changed significantly from the populations surveyed in the early 1950s and 1960s. The lake also contains the following game species: bluegill, rock bass, pumpkinseed sunfish, black crappies, black, brown, and yellow bullheads, bowfin, longnose gar, and spotted gar.

The report noted that Gun Lake is heavily developed and receives substantial boating pressure. Boating pressure has reduced the wild rice beds in the west basin to a fraction of their former size. A fair amount of duck hunting occurs on the lake each fall.

4. *Aquatic Survey of Gun Lake, Barry & Allegan Counties, Michigan* (Krueger, 1997).

AAT Labs completed the aquatic survey for the Gun Lake Protective Association. Thirteen locations were sampled in the lake basin and in associated drains in August 1997. Water samples were analyzed for total phosphorus, nitrate nitrogen, temperature, dissolved oxygen, pH, conductivity and *E. coli* bacteria. Vertical profiling was completed at two locations within the basin. Additional water samples were collected from the Cuddy/Gardiner drain on August 28, 1997, and analyzed for *E. coli*.

The report concluded that Gun Lake had very good dissolved oxygen levels. The observed oxygen concentrations were adequate to support fish to a depth of 50 feet. Nitrate levels were also at acceptable levels, however, an elevated nitrate concentration was observed at the drain leading into Robbins Bay Channel at Patterson Road. The report indicated that this drain contained groundwater base flow. Elevated nitrate concentrations were also observed in the channel on the north side of Robbins Bay. Phosphorus levels were also acceptable with higher concentrations observed near the bottom of the water column, indicating internal recycling of nutrients.

E. coli was present in samples collected from three of the locations on August 12, 1997, the drain leading into Robbins Bay Channel at Patterson Road (1,000 count/100ml), the inlet from Fawn Lake (600 count/100 ml), and the west side of Murphy's Point in the public swimming area (100 count/100ml). The report contended that *E. coli* is entering the drains and lake from storm water runoff because *E. coli* samples collected a day earlier, on August 11, 1997, during a rain event, contained even higher bacteria levels. *E. coli* was also detected in water sampled on August 28, 1997, from seven locations in the Cuddy/Gardiner drain.

5. *Trout Survey, Gun River* (MDNR, 2000).

This survey was conducted at several locations and confirmed the presence of brown trout and white sucker. The average length of brown trout was 8.4 inches.

6. *Species Inventory, Gun River between 110th and 107th Avenues, (Keto, 2001).*

Mr. Dan Keto of the Kalamazoo Nature Center completed an informal survey of the plant and bird species present along the Gun River between 110th and 107th Avenues. He conducted the survey by canoe on May 6, 2001, between 2:30 p.m. and 4:30 p.m. Table 2.3 summarizes the species he observed on that day. The noted plant species are commonly found in rich woods, forested wetlands, and scrub-shrub wetlands. The bird species are generally common in wooded and wetland areas. The blue-winged warbler prefers brushy meadows and secondary growth woodlands. The presence of the black-headed grosbeak is unexpected. This western bird is rarely observed in Michigan.

Table 2.3 - Inventory of Plant and Bird Species Along the Gun River from 110th and 107th Avenues

Birds	Wildflowers	Trees	Shrubs
Great Blue Heron	Tall Meadow Rue	Common Hackberry	Elderberry
Wood Duck	Wild Ginger	Slippery Elm	Red Osier Dogwood
Mallard	Wild Geranium	Red Maple	Dogwood
Turkey Vulture	Blue Violet	Silver Maple	Vibernum
Mourning Dove	Trillium	Elm	Serviceberry
Black-billed Cuckoo	Wild Leek	Red Oak	Honeysuckle
Belted Kingfisher	Nettle	Sycamore	
Red-bellied Woodpecker	Mayapple	Basswood	
Downy Woodpecker	Jack-in-the-Pulpit	Wild Cherry	
Northern Flicker	Skunk Cabbage	Ash	
Eastern Phoebe	False Solomon Seal	Box Elder	
Blue Jay	Wild Phlox (Sweet William)	Walnut	
Black-capped Chickadee	Daisy Fleabane	Sandbar Weeping Willow	
Tufted Titmouse	Equisetum (Horse Tail)	Honey Locust	
White-breasted Nuthatch	Sensitive Fern	Cottonwood	
Blue-gray Gnatcatcher	Avens	Beech	
American Robin	Spring Beauty	Musclewood (Hornbeam)	
Gray Catbird	Virginia Creeper		
Red-eyed Vireo			
Blue-winged Warbler			
Common Yellowthroat			
Northern Cardinal			
Rose-breasted Grosbeak			
Black-headed Grosbeak			
Indigo Bunting			
Rufous Sided Towhee			
Chipping Sparrow			
Song Sparrow			
Red-winged Blackbird			
Common Grackle			
Baltimore Oriole			
American Goldfinch			

Source: Mr. Dan Keto, Kalamazoo Nature Center, 2001.

2.5 FISH STOCKING RECORDS

The MDNR Fisheries Division records indicate that Gun Lake continues to be stocked annually with walleye. In 1999, Gun River was stocked with brown trout at six locations between Old Route 131 and 9th Street.

2.6 INVASIVE SPECIES

1. Zebra Mussels

Zebra mussels were discovered in Gun Lake in 1998 (Michigan Sea Grant Inland Lakes Zebra Mussel Infestation Monitoring Program Record, December 2001). Zebra mussels, *Dreissena polymorpha*, are small, fingernail-sized, fresh water mollusks that were accidentally introduced to North America via ballast water from transoceanic vessels. Since their introduction in the mid-1980s, they have spread rapidly to all of the Great Lakes and an increasing number of inland waterways in the United States and Canada. Zebra mussels colonize on surfaces, such as docks, boat hulls and intake pipes. In some cases, they have completely covered the stems and leaves of aquatic plants. Their only known predators, some diving ducks, freshwater drum, carp, and sturgeon, are not numerous enough to have a significant effect on their population. Zebra mussels were likely introduced to Gun Lake from boats, other recreational watercraft, and bait buckets.

2. Purple Loosestrife

Purple loosestrife (*Lythrum salicaria)* is an aggressive perennial plant native to Europe and Asia. It has been found in wetlands and other moist habitats in Allegan and Barry Counties. Mature plants grow up to 7 feet tall and each produce 30 or more purple flower spikes. These bloom in late summer and can produce over 2.5 million seeds per year. Once established, purple loosestrife frequently becomes the dominant vegetation in a wetland by out-competing native plants. This, in turn, impacts wildlife species that depend upon native wetland plant species for food and habitat. Declines in duck, geese, muskrat, and mink populations have been attributed to the proliferation of purple loosestrife.

According to Michigan Sea Grant, purple loosestrife will unlikely be eradicated from Michigan. However, methods have been developed to control its spread and lessen its influence upon wetland environments. In habitats where just a few isolated plants exist or infestation is localized within a small area, they can be dug up and all of the roots carefully removed. Flower stalks can be bagged, then cut off to prevent seed formation or to remove seed heads. Other control measures must be used in conjunction with cutting in order to reduce purple loosestrife populations.

Approved herbicides may be used to control dense stands of purple loosestrife. Herbicides, however, are nonselective and will kill most vegetation that they contact.

Methods of biological control have also been developed for purple loosestrife. Three plant feeding beetles, *Galerucella calmariensis, Galerucella pusilla,* and *Hylobius transversovittatus*, selectively feed on purple loosestrife, resulting in its demise. These insects have undergone extensive testing and have been approved for use in Michigan.

3. Eurasian Watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) is an exotic submerged plant that grows rapidly and forms a dense canopy on the water surface. It was introduced to North America between the late 1800s and the early 1940s. It is similar to the native Northern watermilfoil, but can be distinguished by a few methods.

a. The Eurasian watermilfoil has 12 to 21 leaflet compared to 5 to 10 pairs of the Northern watermilfoil.

b. Northern watermilfoil leaves tend to be stiff and bristly, while the Eurasian species is limp and clings to the stem when out of the water.

Eurasian watermilfoil is able to reproduce from fragments and spread rapidly. The best defense is to prevent invasion by cleaning boats and bait buckets to prevent transfer. Since watermilfoil is spread by fragmentation, mechanical removal is not recommended. While it may reduce current populations, mechanical harvesting usually exacerbates the problem by spreading fragments around the lake that are capable of forming colonies in following years. Chemical and biologic controls are the only two methods currently in practice that are mildly effective at controlling Eurasian watermilfoil. Unless systemic selective herbicides are used, control can be expensive and must often be reapplied regularly. Systemic herbicides such as fluridone, 2,4-D, and tryclopyr have shown some success at controlling Eurasian watermilfoil. However, herbicides may cause damage to existing native plant species if they are applied incorrectly. Biological control involves the introduction of a species that is either a predator or which affects the organism's life cycle in such a way as to lead to its decline.

The native milfoil weevil (*Euhrychiopsis lecontei*) has been associated with natural declines in Eurasian watermilfoil and has been tested in controlled field and tank experiments. The milfoil weevil feeds and develops only on plants in the *Myriophyllum* genus and prefers Eurasian watermilfoil to the native northern species. Today there are a number of lakes around Michigan that have experimented with weevil control. The progress of the introduction of the milfoil weevil to Gun Lake has not been documented.

4. Garlic Mustard

Garlic mustard (Alliaria petiolata) is native to Europe and was brought to North America by settlers for its culinary and medicinal uses. It is a cool season biennial herb that first appears close to the ground with small green rosettes. The second year, the plant grows to 3 feet tall and is stalked with triangular to heart shaped leaves. Clusters of small white flowers develop into slender black seed pods in May. By late June, most plants have died.

Garlic mustard outcompetes most native wildflowers by taking over light, moisture, nutrients, soil, and space. Wildlife, which depend on the variety of native wildflowers, are driven out of the area. Some leaves may be toxic to butterflies which lay their eggs on the plants, never to hatch.

Management of garlic mustard is a tedious and often unyielding task. Hand pulling of plants is possible for light infestations, but the entire root system must be removed. It is rhizomous and new plants will emerge from roots. For the same reason, herbicides are not always effective. The rhizomes spread widely and herbicides do not always infiltrate to the root system. If herbicides are used, they should be used with care to protect native plants which may repopulate the area. Cutting of plants at ground level before they mature or with a bag over the plant if mature can prevent further spreading of seeds.

5. Other Invasive Plant Species

The non-native, highly invasive plant species listed in Table 2.4 have been observed in Allegan and/or Barry Counties. These species invade natural habitats and replace native species.

Table 2.4 - Inventory of Invasive Plant Species Along the Gun River from 110th and 107th Avenues

Scientific Name	Common Name	Characteristics
Alliaria petiolata	Garlic mustard	Herbaceous, common in disturbed ground, garlic odor
Berberis thunbergii	Japanese barberry	Shrub with spiny stems
Centaurea maculosa	Spotted knapweed	Herbaceous, common in old fields and disturbed ground
Lonicera x bella	Bell's honeysuckle	Shrub
Potamogeton crispus	Curly pondweed	Aquatic perennial herb, pollution tolerant

Source: Mr. Dan Keto, Kalamazoo Nature Center, 2001.

2.7 PRESETTLEMENT VEGETATION

Figure 7 indicates the vegetative communities that were observed within the Watershed around 1800. The presettlement vegetation data was digitized from the original mylar maps used in compiling *Presettlement Vegetation of Southwestern Michigan* by Lawrence G. Brewer, Thomas W. Hodler, and Henry A. Raup of Western Michigan University.

The presettlement vegetation map indicates that hardwood forest and savannah were the predominate plant communities present within the Watershed, comprising approximately 66% of the Watershed's total area.

Forested wetlands comprised approximately 19% of the Watershed. The forested wetlands were located in the floodplains of the Gun River, its tributaries, and around Fish Lake. The remainder of the Watershed contained unforested wetlands (5.7%), waterbodies (5.5%), pine-oak forest (3.2%), shrub-carr (less than 1%) and pine forest (less than 1%). Wetlands were present in approximately 25% of the Watershed.

2.8 NATIONAL WETLANDS INVENTORY

The National Wetlands Inventory (NWI) (Figure 9), notes the presence of various types of wetlands within the Watershed. This map was prepared primarily by stereoscopic analysis of high altitude aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography. NWI maps are not typically field verified and therefore contain a margin of error. This map was prepared in the mid-1980s.

The NWI map indicates that the Watershed contains approximately 86% uplands, 8% wetlands, and 6% open water. Forested wetlands are the most common type of wetland present in the Watershed, covering approximately 5.3 square miles. Emergent wetlands are the next most prevalent type, covering 1.9 square miles. Scrub shrub wetlands are present in approximately 1.2 square miles of the Watershed.

A comparison of the presettlement vegetation map and the NWI map indicates that over two-thirds of presettlement wetlands have been converted to other uses within the Watershed.

2.9 PRIME FARMLAND

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) defines prime farmland as land with the best combination of physical and chemical characteristics for producing crops. This land must be available for agricultural use in order to receive a prime farmland designation. Prime farmland has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming practices.

The USDA NRCS has compiled lists of prime farmland soils for Allegan and Barry Counties (USDA-SCS, 1987, USDA-SCS, 1990). Figure 10 notes the locations of prime farmland within the Watershed. The majority of the prime farmland is located in Martin and Gun Plain Townships. The northern tip of the Watershed also contains a concentration of prime farmland. The Watershed contains approximately 10,771 acres of prime farmland: 8,742 acres in Allegan County, and 2,027 acres in Barry County. The acres and types of soils in each county are calculated in Table 2.5.

Table 2.5 - Prime Farmland Soils in Allegan and Barry Counties, Michigan

Allegan County Prime Farmland Soils		
Soil Mapping Symbol	Soil Name	Acres
8B	Glynwood clay loam	32
12B	Ockley loam	2,232
16B	Capac loam*	771
17	Brookston loam*	66
19A	Brady sandy loam	1,341
22A	Matherton loam*	113
23	Sebewa loam*	1,135
27B	Metea loamy fine sand	389
29	Cohoctah silt loam*	35
30	Colwood silt loam*	602
31B	Tekenink loamy fine sand	112
33A	Kibbie fine sandy loam	138
36	Corunna sandy loam*	115
41B	Blount silt loam*	417
42B	Metamora sandy loam*	237
45	Pewamo silt loam*	36
63B	Riddles loam	35
65	Cohoctah silt loam*	467
75B	Marlette-Capac loams	469
TOTAL		**8,742**

Table 2.5 - Prime Farmland Soils in Allegan and Barry Counties, Michigan

Barry County Prime Farmland Soils		
Soil Mapping Symbol	Soil Name	Acres
7A	Brady sandy loam	108
9B	Capac fine sandy loam*	3
13	Colwood loam*	4
20B	Tekenink fine sandy loam	4
22B	Kalamazoo loam	441
24B	Marlette loam	164
26B	Matherton loam*	65
31B	Oshtemo sandy loam	405
33	Parkhill loam*	2
36	Sebewa loam*	73
37B	Selfridge loamy sand	4
47B	Perrinton loam	13
50B	Kibbie silt loam*	14
60A	Schoolcraft loam	409
60B	Schoolcraft loam	6
63B	Elston sandy loam	164
67B	Marlette-Oshtemo complex	148
TOTAL		**2,027**

* Where drained

The presettlement vegetation map indicates that most of the prime farmland areas formerly contained hardwood forest/savanna and forested wetlands. The prime farmland areas contain a low frequency of endangered, threatened, and special concern species.

2.10 CONCLUSION

The Watershed is a diverse watershed containing a variety of plant communities and land uses. The Watershed has been significantly altered from its presettlement conditions, primarily due to agricultural development. As a result, many of the Watershed's forests have been cleared and the wetlands drained. Relatively undisturbed natural areas remain within the Watershed, including land east of Gun Lake and in the vicinity of Fish Lake. These areas are located within the Yankee Springs State Recreation Area and contain the highest documented density of endangered, threatened, and special concern plant and animal species within the Watershed.

CHAPTER 3 - POLITICAL LANDSCAPE

3.0 DEMOGRAPHICS

The U.S. Census, conducted in 2000, estimated the population and acreage of each governmental unit within the Gun River Watershed (Watershed). Table 3.1 describes the demographics of the area and calculates the population of the Watershed as having 12,642 residents. The Village of Martin, in the western central portion of the Watershed, is an area of concentrated population. The southern end of the Watershed, near the cities of Otsego and Plainwell, is also heavily populated. The Watershed lies in Allegan and Barry Counties. The majority of the Watershed is included in the Allegan County Townships of Gun Plain, Martin, and Wayland and the Barry County Townships of Orangeville, Yankee Springs, and Thornapple. Small portions of Leighton, Watson, and Otsego Townships in Allegan County, and Prairieville Township in Barry County are also included.

The total acreage of the Watershed, depicted in Table 3.1, shows a slightly greater acreage in Allegan County, at 56.9% of the Watershed, than in Barry County, at 43.1% of the Watershed. The upper reaches, including the majority of Gun Lake and its contributing area are in Barry County. The lower reaches, including the Gun River outlet to the Kalamazoo River, are in Allegan County. Within Allegan County, Martin Township holds 25.6% of the Watershed, Gun Plain Township has 19.4%, and Wayland Township has 10.1%. The Village of Martin and Leighton Township have less than 1% of the Watershed. Otsego Township has only 1.3% of the total Watershed, a total of 980 acres, in which the Gun River enters the Kalamazoo River. Within Barry County, Orangeville Township contains 22.7% of the Watershed and Yankee Springs Township has 15.7% of the Watershed, both of which contain parts of Gun Lake. Thornapple Township contributes the uppermost 4.3% of the Watershed. Prairieville Township contains just 0.5% of the Watershed.

Table 3.1 also illustrates the population concentration variations by governmental unit across the Watershed. The percent population change in most areas, at an average of 14.5%, was close to the 13.1% national average, but was greater than the 6.9% growth rate for Michigan. Population change ranged from a net loss of 6.9% of the population in Prairieville Township to a net gain of 41.7% in Yankee Springs Township. The population in the United States as a whole is 79.6 people per square mile and 175.0 per square mile for the population in Michigan. The population in the Watershed falls in between at 111.8 people per square mile, with the largest concentrations being the Village of Martin at 574 people per square mile. Gun Plain Township, Leighton Township, Otsego Township, Thornapple Township, and Yankee Springs Township all have population densities greater than 100 people per square mile. Martin Township, Watson Township, Wayland Township, Orangeville Township, and Prairieville Township all have populations that are less than 100 people per square mile.

Ethnic diversity is generally low in the Watershed, as shown in Table 3.2, where 97.02% of the population is white. The largest minority is Hispanic or Latino, with approximately 231 residents throughout the Watershed. Approximately 63 people classify themselves as American Indian or Alaska Native. Less than half of one percent each is Asian, Black or African American, Hawaii Native or other Pacific Islander, or other race. One percent of the population responded as being of mixed race. The population is nearly evenly split between males and females, with slightly more males, especially in the less densely populated areas.

Table 3.1 - Acres and Population of the Gun River Watershed

Governmental Unit	Total Acres[1]	Acres in Watershed[2]	Square Miles in Watershed[2]	Govt. Unit % of Watershed[2]	Watershed % of Govt. Unit[2]	Population 1990 Census[3]	1990 Population per Square Mile	Population 2000 Census[3]	2000 Population per Square Mile	% Change 1990-2000	Estimated 2000 Pop. In Watershed
Allegan County	529,280	41,656	65.09	56.9%	7.9%	90,509	109.4	105,665	127.8	16.7%	8,316
Gun Plain Township	22,391	14,220	22.22	19.4%	63.5%	4,754	135.9	5,637	161.1	18.5%	3,580
Leighton Township	22,813	14	0.02	0.0%	0.1%	3,069	86.1	3,652	102.5	18.9%	2
Martin Township	22,590	18,772	29.25	25.6%	82.9%	2,487	70.5	2,514	71.2	1.1%	2,084
Martin Village	485	242	0.38	0.3%	50.0%	N/A	N/A	435	574.2	N/A	217
Otsego Township	21,926	980	1.53	1.3%	4.5%	4,780	139.5	4,854	141.7	1.5%	217
Watson Township	23,046	80	0.13	0.1%	0.3%	1,897	52.7	2,086	57.9	10.0%	7
Wayland Township	21,562	7,397	11.56	10.1%	34.3%	2,569	76.3	3,013	89.4	17.3%	1,034
Barry County	355,840	31,615	49.40	43.1%	8.9%	50,057	90.0	56,755	102.1	13.4%	5,043
Orangeville Township	22,835	16,625	25.98	22.7%	72.8%	2,880	80.7	3,321	93.1	15.3%	2,418
Prairieville Township	23,342	376	0.59	0.5%	1.6%	3,409	93.5	3,175	87.1	-6.9%	51
Thornapple Township	22,788	3,137	4.90	4.3%	13.8%	5,226	146.8	6,685	187.7	27.9%	920
Yankee Springs Township	22,931	11,478	17.93	15.7%	50.1%	2,977	83.1	4,219	117.8	41.7%	2,112
Total (not including county populations)	**226,708**	**73,271**	**114.49**	**N/A**	**N/A**	**34,048**	**96.1**	**39,591**	**111.8**	**14.5% (average)**	**12,642**

1 - Western Michigan University GIS
2 - Adapted from Western Michigan University GIS
3 - U.S. Census

Table No. 3.2 – Ethnic Diversity in the Gun River Watershed

Governmental Unit	2000 Total Population[1]	Watershed % of Govt. Unit[2]	Watershed Population[3]	Male[3]	Female[3]	White[3]	Black or African American[3]	Amer. Indian & Alaska Native[3]	Asian[3]	Native Hawaiian & Other Pacific Islander[3]	Hispanic or Latino[3]	Other Race[3]	One Race[3]	Two or More Races[3]
Allegan County	105,665	7.9%	8,316	52,730	52,935	98,769	1,385	576	582	35	6,040	2,924	104,271	1,394
Gun Plain Township	5,637	63.5%	3,580	1,792	1,788	3,481	13	12	13	2	39	14	3,535	45
Leighton Township	3,652	0.1%	2	1	1	2	0	0	0	0	0	0	2	0
Martin Township	2,514	82.9%	2,084	1,043	1,040	2,016	3	7	13	0	44	23	2,063	21
Martin Village	435	50.0%	217	110	107	208	1	2	1	0	6	5	217	0
Otsego Township	4,584	4.5%	205	109	108	211	1	1	1	0	3	1	214	3
Watson Township	2,086	0.3%	7	4	3	7	0	0	0	0	0	0	7	0
Wayland Township	3,013	34.3%	1,034	541	493	997	4	15	3	0	23	8	1,028	6
Barry County	56,755	8.9%	5,043	28,334	28,421	55,276	139	263	153	5	831	281	56,117	638
Orangeville Township	3,321	72.8%	2,418	1,241	1,176	2,333	8	15	2	0	69	30	2,389	29
Prairieville Township	3,175	1.6%	51	26	26	50	0	0	0	0	1	0	50	1
Thornapple Township	6,685	13.8%	920	457	463	892	1	4	4	1	13	6	908	13
Yankee Springs Township	4,219	50.1%	2,112	1,056	1,056	2,056	6	8	4	1	33	10	2,083	29
Total (not including county population)	39,321	N/A	12,630	6,381	6,262	12,254	37	63	42	3	231	97	12,496	146
% of Watershed Population				50.52%	49.58%	97.02%	0.29%	0.50%	0.33%	0.02%	1.83%	0.76%	98.94%	1.16%

1 - 2000 Census
2 - Adapted from Western Michigan University GIS
3 - Township and Village populations are projected based on percentage of area in Watershed from U.S. Census

3.1 COMMUNITY PROFILES

Agriculture is an important part of the community in the Watershed and much of the marshy areas have been drained to reveal fertile soil. Located approximately halfway between the large cities of Kalamazoo and Grand Rapids, Gun Lake is a retreat for many who work and reside in these cities. Recreation with small watercraft is popular on the lake during summer months. Fishing and hunting also occur in the Barry County State Game Area, located north of Gun Lake. Yankee Springs Recreational Area, also north of Gun Lake, is a popular place for hiking, wildlife viewing, cross country skiing, and snowshoeing.

The school districts in the Watershed include Martin Public Schools, Otsego Public Schools, Plainwell Public Schools, Wayland Public Schools, Hastings Area School District, and Thornapple Kellogg School District. Opportunities for adult education also exists in most of these school districts.

3.2 GOVERNMENT OFFICIALS

Watershed management involves local stakeholders and decision-makers. Communication between all of these representatives is essential to achieve the goals and objectives of the WMP. Table 3.3 lists the federal, state, county, township, and village officials that have a vested interest in the Watershed. The continued involvement of these individuals and agencies will contribute to the successful planning process of this project.

Table No. 3.3 - Officials

Name		Phone Number
United States and Michigan		
Ms. Debbie Stabenow	U.S. Senator	202-224-4822
Mr. Carl Levin	U.S. Senator	202-224-6221
Mr. Peter Hoekstra	U.S. Representative 2nd Congressional District	202-225-4401
Mr. Frederick Upton	U.S. Representative 6th Congressional District	202-225-3761
Ms. Patricia Birkholz	State Senate District 24	517-373-3447
Mr. Fulton Sheen	State Representative District 88 for Allegan County	517-373-8728
Ms. Joanne Emmons	State Senate District 23 for Barry County	517-373-3760
Ms. Mary Ann Middaugh	State Representative District 80 for Allegan County	517-373-5940
Mr. Gary Newell	State Representative District 87 for Barry County	517-373-0842
Allegan County		
Mr. Blaine Koops	County Sheriff	269-673-0500
Ms. Joyce Watts	County Clerk and Register of Deeds	269-673-0450
Ms. Sally Brooks	County Treasurer	269-673-0260
Mr. Lynn Fleming	Drain Commissioner	269-673-0440
Mr. Jeroen Wagendorp	Land Information Services Department	269-673-0518
Mr. William Hinz	Environmental Health Department	269-673-5411
Mr. Larry Johnson	MSU Extension	269-678-0370
Ms. Mary Jones	Resource Recovery	269-686-4562
Mr. Kevin Ricco	Parks Commission and Tourist Council	269-673-0378
Mr. Lynn Fleming	Public Works	269-673-0440

Table No. 3.3 - Officials

Name		Phone Number
Mr. William Nelson	Road Commission	269-673-2184
Ms. AnneMarie Chavez	Conservation District	269-673-8965
Local Elected Officials		
Ms. Shelly Edgerton	Gun Plain Township, Supervisor	269-685-9471
Mr. Darwin VanderArk	Leighton Township, Supervisor	269-891-2143
Mr. Terry Sturgis	Martin Township, Supervisor	269-672-5027
Mr. Gale Dugan	Otsego Township, Supervisor	269-694-9434
Ms. Cathy Pardee	Watson Township, Supervisor	269-672-7254
Mr. Randy Marklevitz	Wayland Township, Supervisor	269-792-6394
Mr. Gary Brinkhuis	Village of Martin	269-672-5264
Barry County		
Mr. Stephen H. DeBoer	County Sheriff	269-948-4805
Ms. Debbie S. Smith	County Clerk	269-945-1285
Ms. Darla Burghdoff	County Register of Deeds	269-945-1289
Ms. Susan VandeCar	County Treasurer	269-945-1287
Mr. Tom Doyle	Drain Commissioner	269-945-1385
Mr. Thomas W. Spencer	Health Department	269-945-4304
Mr. David Shinavier	Land Information Services/Mapping	269-945-1291
Ms. Janice Hartough	MSU Extension	269-945-1388
Mr. James McManus	Planning and Zoning	269-945-1290
Mr. Tom Doyle	Public Works	269-945-1385
Mr. Norman Jack Lenz	Road Commission	269-945-3449
Ms. Joanne Barnard	Conservation District	269-948-8056
Local Elected Officials		
Mr. Lee Cook	Orangeville Township, Supervisor	269-664-4522
Mr. Mark Doster	Prairieville Township , Supervisor	269-623-2664
Mr. Donald E. Boysen	Thornapple Township, Supervisor	269-795-7202
Mr. Al McCrumb	Yankee Springs Township, Supervisor	269-795-9091

CHAPTER 4 - WATER QUALITY IN THE GUN RIVER WATERSHED

Gun River and its tributaries have suffered impairments over the years due to human-based land use activities. Biosurveys conducted by the Michigan Department of Environmental Quality (MDEQ) indicate that habitats and biological communities in the Gun River Watershed (Watershed) are significantly degraded due to nonpoint source (NPS) pollution. The MDEQ has listed the following waterbodies in the Watershed on the 303(d) non-attainment list for not meeting designated uses and scheduled the due date for establishing a Total Maximum Daily Load (TMDL).

Waterbody	Impairment	TMDL Year
Gun Lake	Pathogens	2011
Gun River	Poor macroinvertebrate community	2011
	Phosphorus	2011
Fenner Lake	Polychlorinated biphenyls (PCBs)	2010
	Mercury	2011
	Nutrients	2000
Fish Lake	Mercury	2011
Selkirk Lake	Mercury	2011

The Gun River ranks as the third highest contributor of phosphorus loads to the Kalamazoo River/Lake Allegan system as determined by the MDEQ's sampling results. Other significant water quality impairments include degraded indigenous aquatic habitat, decline of biotic diversity, and reduced fish populations caused by sedimentation and excessive nutrients.

4.0 PREVIOUS AND CURRENT STUDIES

Several previously conducted studies were reviewed in Chapter 2, focusing on the biological conditions within the Watershed. Further discussion of these studies is included in this chapter to present water quality parameters and the water chemistry conditions in the Watershed.

4.0.1 KALAMAZOO RIVER REMEDIAL AND PREVENTIVE ACTION PLAN

The Kalamazoo River was officially recognized as an Area of Concern (AOC) by the governments of Canada and the United States in 1987. The lower portion of the Kalamazoo River was identified as an AOC because of the presence of PCBs, discharged primarily from historic de-inking operations at local paper mills.

A Public Advisory Council (PAC) for the Kalamazoo River AOC drafted a Remedial Action Plan (RAP) as required by the Great Lakes Water Quality Agreement for each AOC. The goals of the RAP are to restore and protect the Kalamazoo River aquatic ecosystem and protect public health. The implementation of the recommendations in the WMP will contribute toward reaching the overall goals of the Kalamazoo River RAP.

Currently, eight use impairments are recognized in the Kalamazoo River AOC. The entire list can be found in Appendix 1. Three problems on the list are shared in the Watershed; degradation of fish and wildlife populations, degradation of the benthos, and loss of fish and wildlife habitat. The PAC has declared these problems as plaguing the entire Watershed. For every problem, recommendations have been made for the required actions to remedy the problems. Recommendations for restoring habitat and increasing fish and wildlife populations include erosion control, sediment removal, and public education.

4.0.2 KALAMAZOO RIVER/LAKE ALLEGAN TMDL

Phosphorus concentration were measured in the Kalamazoo River and selected tributaries in 1998 by MDEQ. The Lake Allegan/Kalamazoo River TMDL has identified the Gun River Watershed as the third largest contributor of phosphorus loads to the Kalamazoo River. The Watershed is characterized as an example of a predominantly agricultural area for the type of NPS pollution it receives. Additional modeling determined the nonpoint source phosphorus loading predictions for the Gun River Watershed as 6,117 lbs/season (April 1 – September 30, 1998) and 11,119 lbs/year (Kieser & Associates, 2001).

The Gun Lake Wastewater Treatment Plant's permitted point source load was 915 pounds of phosphorus during the months of April to September 1998. The plant had an actual load of 63 pounds. The monthly discharges of phosphorus from major point sources, including the Gun Lake Sewer & Water Authority can be viewed at: http://www.kalamazooriver.net/cgi/ps_v2/intro.cgi.

Agriculture is the foremost land use in addition to the largest contributor of phosphorus loading in the Watershed. The TMDL Implementation Committee invited three representatives of the agricultural areas in Allegan, Calhoun, and Kalamazoo Counties to serve as stakeholders in a series of sessions. During the sessions a series of Best Management Practice (BMP) recommendations from agricultural producers for phosphorus reduction was synthesized.

Three key components to implementing reductions were formed; nutrient management, conservation practices, and manure and fertilizer storage. Discussion on these components formulated a few key concepts to reducing phosphorus delivery. One was the need for a systems approach on farms. Many of the farmers' concerns about the environmental degradation effects that plague their production can be remedied to result in lower phosphorus use and runoff. A second topic was the need for government

supported conservation programs. Too often the technical assistance for implementing BMPs is not available. A third concern was lack of funding for phosphorus reduction practices in addition to standard BMPs. Many agricultural users are interested in limiting use of fertilizers to reduce total production cost at the same time reducing phosphorus delivery. However, soil and manure testing is very expensive and funding opportunities or agencies to perform these tests are limited. Finally, the stakeholder session acknowledged the importance of the current 319 Watershed Project as a cost share opportunity and recognized that the role of the watershed coordinator is extremely important as a contact and technical assistant.

4.0.3 AQUATIC SURVEY OF GUN LAKE

A private water testing lab was hired in 1997 to conduct water quality sampling in Gun Lake. Samples were focused on Gardiner Drain, where elevated *E. coli* levels were suspected. A total of 13 sites were sampled. The parameters tested included total phosphorus, nitrogen as nitrate, temperature, dissolved oxygen, pH, conductivity, and *E. coli*. Secchi disk readings ranged from 11 feet to 12 feet. Two public swimming areas on the west and east side of Murphy's Point were tested for *E. coli*. Both samples were below the Michigan minimum water quality standards of 300 count per 100 ml for total body contact, measured at a slightly elevated level of 100 count per 100 ml, and 0 count per 100 ml, respectively (Krueger, 1997). Additionally, vertical profiles of the lake were measured for all parameters except conductivity and *E. coli*. Supplemental sampling include testing for *E. coli* at various locations along the Cuddy and Gardiner Drains.

The results of the sampling indicated that the high concentration of phosphorus at the bottom of the lake was caused by years of nutrients settling into the sediment. Nitrates were not at elevated levels and very little changes in the nitrate levels occur throughout the water column. Dissolved oxygen levels were sufficient to support fish to a depth of 50 feet. *E. coli* was tested during a rainfall, and then again the next day when the rain had subsided. The *E. coli* levels were elevated during the rain event, indicating that *E. coli* could be entering the drain from storm water runoff.

4.0.4 BIOLOGICAL SURVEY OF THE GUN RIVER

A biological survey and water quality sampling of the Gun River was conducted on July 26, 1989, by the Michigan Departent of Natural Resources (MDNR). The water quality parameters tested included nitrite, nitrate and nitrite, ammonia, Kj nitrogen, ortho phosphate, total phosphorus, SS, and turbidity. A macroinvertebrate survey, sediment sampling for metals, and an assessment of the physical habitats were also conducted. The water chemistry was considered to be suitable for trout habitat, having changed little over the previous ten years. The increase in sedimentation, however, had significantly impaired the macroinvertebrate communities.

The MDEQ performed a biological survey on the Kalamazoo River and its tributaries in the summer of 1999. The tests conducted in the Watershed concluded that the water quality parameters were within the normal ranges for streams in this ecoregion, however, rainfall was far below normal that summer, and the study warned that the results were most likely understated. Sedimentation, however, mostly from channel modification, was impairing the macroinvertebrate and fish communities.

4.0.5 FISHERY STUDIES IN THE GUN RIVER WATERSHED

The MDNR conducted a stream general survey and trout evaluation of the Gun River on September 13, 2000. The field crew used a Smith Root Intermediate Boom shocker to stun the fish, which enabled the crew to collect and record information about the trout population. The crew surveyed areas in the vicinities just downstream of 110th Avenue, downstream of 7th Street, and upstream of the Gun River Conservation Club. The habitats of all three areas were described as having logs, some brush, a few pools, and "nice stump holes." The gradient of the stream was more pronounced near the Gun River Conservation Club. Eel grass was very sparse in all areas. Very few minnows and sculpins were observed. The water was clear at the time of the survey. Typical stream bottom consisted of 80% fine sand (0.1 to 0.3 mm), 10% gravel, 8% silt, and 2% rock. Table 4.1 presents the information collected on the trout population.

Table 4.1 - MDNR General Survey and Trout Evaluation of the Gun River

Species	Number	Percent by Number	Weight (lb.)	Percent by Weight	Length range (in.)*	Average Length (in.)	Percent legal size **
Brown Trout (boom shock 2.41 acres)	50	54.9	11.7	100	6 - 14	8.4	48
White Sucker (boom shock 0.42 acres)	41	45.1	0	0	0	0	0
Total	91	100	11.7	100	-	-	-

* Note some fish may be measured to 0.1 inch, others to 1.0 inch group, e.g., "5" = 5.0 to 5.9 inches
** Percent legal or acceptable size for angling

A 1989 study of Gun Lake, conducted by the MDNR, concluded that the composition of the fish population has not changed significantly in 50 years. The abundance of game species, however, has varied over the years resulting in diverse management strategies for the Lake. Presently, the Lake provides a good fishery for walleye and the northern pike fishery has been steadily improving. The muskellunge population has declined to only a small fraction of the once popular fish. Bass anglers have success with both smallmouth and largemouth bass. Panfish and perch are both average fisheries (Duffy, 1991).

Management directions recommended in 1991 for Gun Lake still hold true today. Walleye fingerlings are stocked annually and good habitat exists for their continued growth and reproduction. The report includes tables of the species and relative abundance of fishes, mean length and age of fish, and a stocking summary from 1921 to 1989 (Duffy, 1991).

A similar study occurred on Fish Lake, east of Orangeville in Barry County. The overall fish populations are good, especially for bluegill, walleye, and northern pike. Stocking of walleye and brown trout was not successful, and the MDNR published a report in 2000 that recommended stocking be discontinued. The Lake is currently being managed as a self-sustaining warmwater fishery (Wesley, 2000).

4.0.6 WATER QUALITY SAMPLING ON THE GUN RIVER

The Gun River Watershed Steering Committee (Steering Committee) desired more information about the quality of the water in the Watershed, which the previous studies could not provide. The Gun River Sewer & Water Authority volunteered to conduct preliminary water quality sampling to determine what areas might need further and more in-depth investigation. A commitment was also received from the Menasha Corporation, a paperbound product plant in Otsego, to provide additional analysis on the water samples collected. The purpose of the sampling was to get information about general ambient phosphorus concentrations, which would provide an insight into the productivity of the system. The Sewer & Water Authority agreed to run tests for phosphorus (ortho and total), suspended solids, and nitrite and nitrate. Dissolved oxygen, temperature, and pH were measured in the field. A total of five locations were visited once a month to collect the data. Menasha ran the same tests on the Greggs Brook Drain, Orangeville Drain, and Fenner Creek Drain sampling locations to calibrate the results. Additional tests run by Menasha included conductivity, nitrate, nitrite, and ammonia. The results of the testing were used to inform the Steering Committee of potential problems in the Watershed, and to assist in determining the critical areas in which to focus BMP implementation. The results of the sampling are compiled in Table 4.2 and the sampling sites for all of these studies are depicted in Figure 11.

Suspended solids (SS) are any particulate matter that is carried in stream flow. These solids may be the result of storm water runoff from urban or agricultural sources or from in-stream erosion. SS harm aquatic life when levels become high enough to block light penetration, fill riffle areas, or cover spawning grounds. The conditions created by SS promote bacterial growth and low dissolved oxygen levels, due to increased water temperature and lack of photosynthesis that occurs when turbidity increases.

Water quality parameters have not been established by the Environmental Protection Agency (EPA) for allowable levels of SS. Although, TMDL have been applied to waterbodies. The allowable level for SS is based on natural levels, the type of sediment being carried, and the impairment to aquatic life. The MDEQ has not required a TMDL for SS for any waterbody in the state. Federal regulations require that effluent being discharged into any lake or stream have a SS less than 30 mg/L. Fenner Creek Drain sampling results had a SS range of 3 mg/L to 30.4 mg/L.

Phosphorus is only slightly toxic to aquatic life; however, the increased eutrophication that results, weakens fisheries and causes impairments to recreational use. Phosphorus forms a strong organic bond to clay particles thus making it a limiting nutrient in aquatic ecosystems. However, increased levels of SS from agricultural runoff facilitates nutrient loading. Chart 4.1 illustrates the levels of phosphorus measured at the sampling sites. Once in the water column, a pound of phosphorus can produce 500 pounds of aquatic plants. When aquatic biomass becomes this high, the likelihood of a fish kill rapidly increases.

The Gun River is the third highest contributor of phosphorus in the greater Kalamazoo River Watershed, which has a TMDL goal for total phosphorus of 0.06 mg/L. Lakes begin eutrophication when phosphorus levels increase above 0.025 and rivers begin to suffer from dissolved oxygen depletion when levels are above 0.1 mg/L. Levels of phosphorus in the sampling sites show a downward trend over the winter. This could be due to decreased runoff and the subsidence of manure spreading outside of the growing season. However, levels of total phosphorus are still too high to meet the Kalamazoo TMDL goal.

Game fish, especially brown trout, are highly sensitive to changes in temperature and will leave an area in search of more suitable habitat when temperatures are as little as two degrees above or below their optimum. Michigan Water Quality Standards suggest that temperatures for coldwater fisheries never exceed 20°C and warmwater fishery temperatures never exceed 32°C. Coldwater fish species require dissolved oxygen levels at or above 7 mg/L, and colder water temperatures allow higher dissolved oxygen concentrations. Dissolved oxygen levels are shown in Chart 4.2. Warmer water temperatures also enhance the toxic effects of cyanides, phenol, and zinc.

The designated uses of coldwater and warmwater fisheries were specified as being impaired in the Watershed. Temperature data gathered over the 2 years of sampling (Chart 4.3) show water temperature exceeding 20°C at the outlet of the lake, which is to be expected. Additional sampling sites downstream are required to judge the level of impairment to the coldwater fishery.

Table 4.2 - Water Quality Sampling Data (Lab: Gun Lake Area Sewer and Water Authority)

pH

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03
Gun Lake Outlet	8.6	7.9	7.8	8.3	8.2	8.0	7.6	7.7	8.3	7.3	7.2	7.4	7.6	7.7	7.5	7.6	7.7	7.6	7.6	7.3	7.7	8.1	8.2	8.2
Discharge Ditch		7.5	7.3	7.7	7.9	7.8	7.5	7.2	7.0	6.9	7.2	7.1	7.3	7.3	7.5	7.6	7.4	7.5	7.4	6.9	7.3	7.3	7.5	7.7
Greggs Brook	8.3	7.6	7.2	7.8	8.1	7.9	7.7	7.2	7.1	7.0	7.2	7.3	7.5	7.4	7.6	7.6	7.5	7.5	7.6	7.5	7.2	7.4	7.4	7.6
Orangeville Drain	8.3	7.8	7.7	8.1	8.2	7.9	7.6	7.6	7.4	7.1	7.3	7.4	7.6	7.6	7.7	7.7	7.6	7.6	7.5	7.0	7.4	7.4	7.7	7.2
Fenner Drain		7.5	7.6	8.1	8.1	7.8	8	7.8	7.5	7.1	7.2	7.4	7.6	7.6	7.5	7.6	7.6	7.5	7.3	7.2	7.5	7.6	7.8	7.7

Phosphorus (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03
Gun Lake Outlet	0.014	0.021	0.009	0.007	0.013	0.01	0.011	0.012	0.013	0.012	0.022	0.007	0.027	0.022	0.009	0.006	0.006	0.012	0.01	0.012	0.013	0.022	0.015	0.004
Discharge Ditch	0.055	0.041	0.032	0.024	0.015	0.02	0.018	0.024	0.083	0.065	0.037	0.043	0.061	0.038	0.067	0.093	0.031	0.024	0.021	0.049	0.037	0.074	0.026	0.027
Greggs Brook	0.127	0.146	0.104	0.035	0.06	0.102	0.045	0.067	0.122	0.111	0.049	0.071	0.083	0.116	0.037	0.099	0.077	0.035	0.046	0.124	0.054	0.099	0.061	0.055
Orangeville Drain	0.052	0.079	0.016	0.011	0.009	0.013	0.015	0.012	0.015	0.012	0.012	0.007	0.046	0.012	0.011	0.013	0.011	0.011	0.011	0.023	0.016	0.016	0.013	0.054
Fenner Drain	0.087		0.052	0.031	0.01	0.015	0.021	0.033	0.051	0.012	0.022	0.016	0.026	0.048	0.015	0.018	0.028	0.017	0.015	0.024	0.002	0.024	0.022	0.061

Dissolved Oxygen (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03
Gun Lake Outlet	8.48	8.77	9.84	9.4	10.7	7.8	6.16	4	4.6	4.6	2.1	8.2	14.3	14.8	13.9	15	13.2	9.3	9.1	6.1	7.6	8.6	10.9	10.1
Discharge Ditch		4.48	4.77	6.3	7.6	8.5	4.45	2.2	4.2	4.1	5	6.7	11.2	8.1	10	9.4	7.7	10.1	7.6	5.7	0.5	6.5	9.8	9
Greggs Brook	7.43	8.27	8.32	9.1	10.8	10.5	6.18	5.4	4.9	5.8	7.1	8.1	12.6	11.1	9.8	10.4	12.9	11.8	10.4	12.9	3.4	8.5	9	9.2
Orangeville Drain	8.00	8.62	8.88	8.5	9.52	7.2	5.75	4.7	4.9	5.5	6.7	8.5	14.1	13.7	16.6	15.9	13.5	10.3	15.9	7.9	8.3	8.1	10	9.8
Fenner Drain	8.01	8.46	8.95	9.96	10.57	8.9	6.32	5.4	5.6	5.3	7.4	9	13.5	13.6	13.9	13.4	13.5	11.8	9.9	8.7	8.5	8.4	10	9.9

Temperature (Celsius)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03
Gun Lake Outlet	6.9	2.6	3.3	5.2	0.1	12	20.6	26.9	26	23	16.1	5.8	2.6	1.7	2.7	1.6	5.6	15.3	18.4	22.8	24.9	26	13.6	8.9
Discharge Ditch		6.7	7.3	9.3	4.8	11.8	14	16.2	16	13.9	11.3	7.9	7.8	7.6	5	3.3	5.5	9.4	10.5	12.8	19.5	18.4	12.9	9.4
Greggs Brook	7.5	3.9	4.0	6.9	1.9	10.4	14.6	17.4	18	14.6	10.7	5.7	4.1	3.9	1.5	1.4	4	10.3	1.4	4	16.7	19.2	10.3	6.9
Orangeville Drain	7.8	4.1	3.7	6.2	2.4	13.3	18.5	22.4	23.6	20.2	15.5	6.8	4.1	2.7	0.5	0.3	4	12.8	14.4	18.2	22.1	23.3	13.6	7.4
Fenner Drain	7.7	4.5	3.8	6.8	2.3	12.8	16	19.4	20.5	16.3	10.9	5.2	3.9	3.7	1.1	1.4	3.1	9.9	11.6	15.9	18.4	18.7	11	6.8

Table 4.2 - Water Quality Sampling Data (Lab: Menasha)

pH

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Gun Lake Outlet	6.6																						
Greggs Brook	7.6	7.7	7.3	7.9	N/A	7.9	7.5	7.6			8.1	8.0											
Orangeville Drain	7.8	7.7	8.0	8.0	N/A	7.9	7.7	8.2			8.3	8.3											
Fenner Drain	7.6	7.6	7.7	7.9	N/A	7.9	7.7	7.8			8.2	8.1											

Conductivity

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	
Gun Lake Outlet	330																						
Greggs Brook	610	630	590	600	N/A	590	610	570			560	580											
Orangeville Drain	440	440	440	440	N/A	450	430	410			410	430											
Fenner Drain	730	730	730	720	N/A	770	760	810			810	800											

Nitrate (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02											
Gun Lake Outlet	0.3																						
Greggs Brook	2.0	2.8	8.0	11.0	N/A	N/A	3.1	2.1			1.1	2.4											
Orangeville Drain	0.3	0.3	2.0	1.0	N/A	N/A	0.2	0.3			0.2	0.2											
Fenner Drain	2.7	3.9	13.0	11.0	N/A	N/A	4.5	4.2			4.9	4.4											

Nitrite (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02											
Gun Lake Outlet	0.0039																						
Greggs Brook	0.0705	0.0330	0.0900	0.0800	N/A	N/A	0.0900	0.1500			0.0600	0.0700											
Orangeville Drain	0.0037	0.0040	0.0200	0.0200	N/A	N/A	0.0100	0.0100			0.0100	0.0100											
Fenner Drain	0.0328	0.0340	0.1100	0.1000	N/A	N/A	0.0500	0.0600			0.0200	0.0400											

Ammonia (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02											
Gun Lake Outlet	0.167																						
Greggs Brook	0.414	0.375	0.360	0.230	N/A	0.140	0.280	0.350			0.140	0.450											
Orangeville Drain	0.158	0.175	0.210	0.160	N/A	0.120	0.180	0.180			0.060	0.080											
Fenner Drain	0.269	0.224	0.210	0.120	N/A	0.080	0.150	0.220			0.130	0.110											

Ortho-P (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02											
Gun Lake Outlet	0.023																						
Greggs Brook	0.066	0.080	0.040	0.060	N/A	0.020	0.030	0.060			0.050	0.100											
Orangeville Drain	0.019	0.050	0.050	0.060	N/A	0.010	0.030	0.030			0.030	0.040											
Fenner Drain	0.037	0.050	0.050	0.050	N/A	0.010	0.030	0.050			0.050	0.030											

Total P (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	
Gun Lake Outlet	0.052																						
Greggs Brook	0.185	0.220	0.050	0.040	0.040	0.070	0.050	0.070	0.130	0.110	0.200	0.090	0.100	0.240	0.050	0.110	0.060	0.050	0.060	0.080	0.050	0.090	
Orangeville Drain	0.135	0.050	0.020	0.010	0.020	0.090	0.020	0.020	0.030	0.020	0.090	0.020	0.020	0.020	0.020	0.030	0.020	0.020	0.020	0.020	0.030	0.020	
Fenner Drain	0.578	0.120	0.070	0.040	0.030	0.080	0.040	0.040	0.040	0.030	0.080	0.020	0.030	0.100	0.030	0.040	0.040	0.030	0.020	0.030	0.030	0.030	

Suspended Soilds (mg/L)

Sampling Site	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02											
Gun Lake Outlet	2.0																						
Greggs Brook	20.4	18.8	7.0	5.6	N/A	4.0	8.0	12.8			4.0	1.6											
Orangeville Drain	0.4	3.6	2.0	1.2	N/A	3.0	4.0	2.4			4.0	1.0											
Fenner Drain	25.6	30.4	16.0	10.8	N/A	3.0	8.0	16.0			5.0	4.0											

Chart 4.1 - Gun River Total Phosphorus

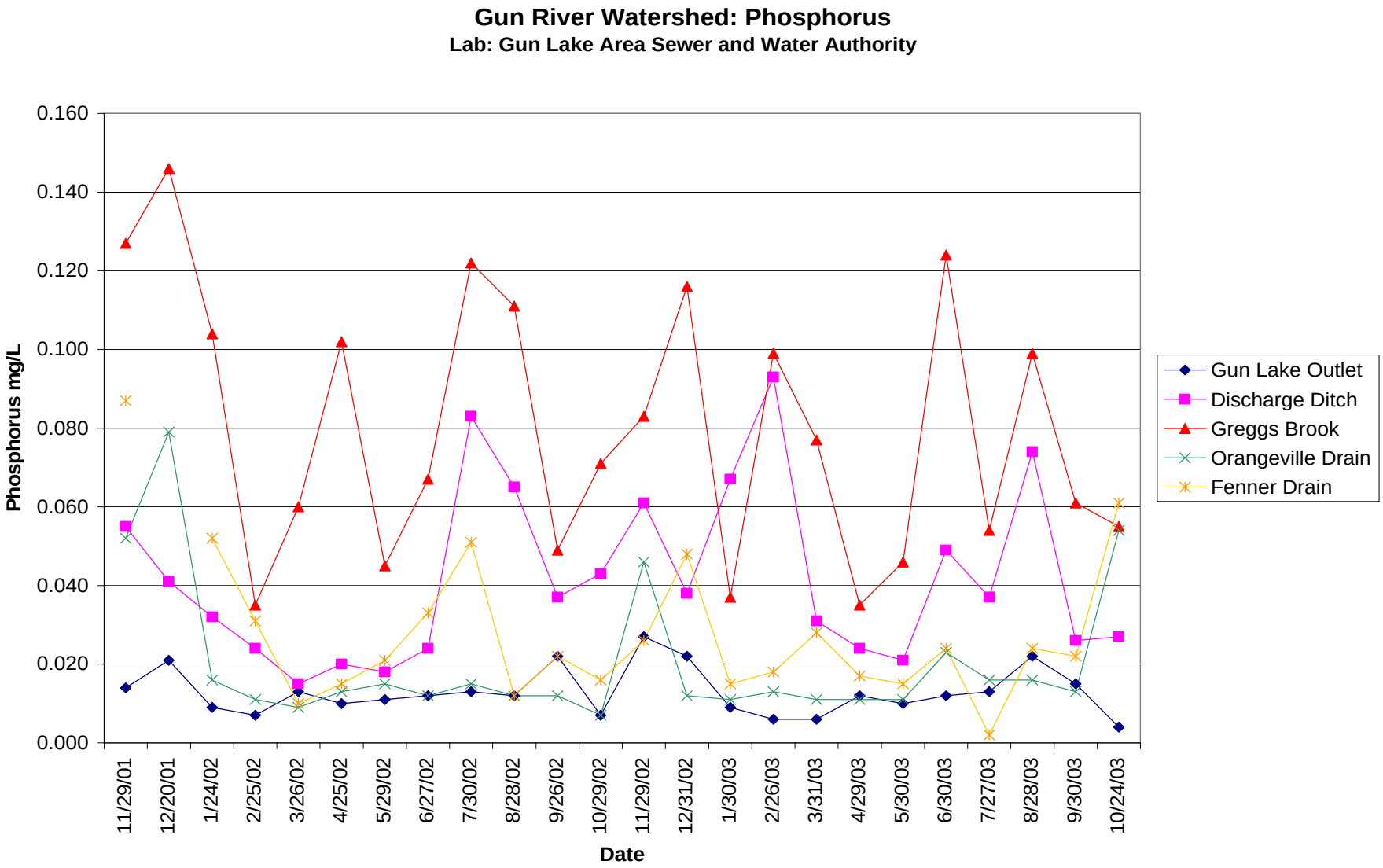


Chart 4.2 - Gun River Dissolved Oxygen

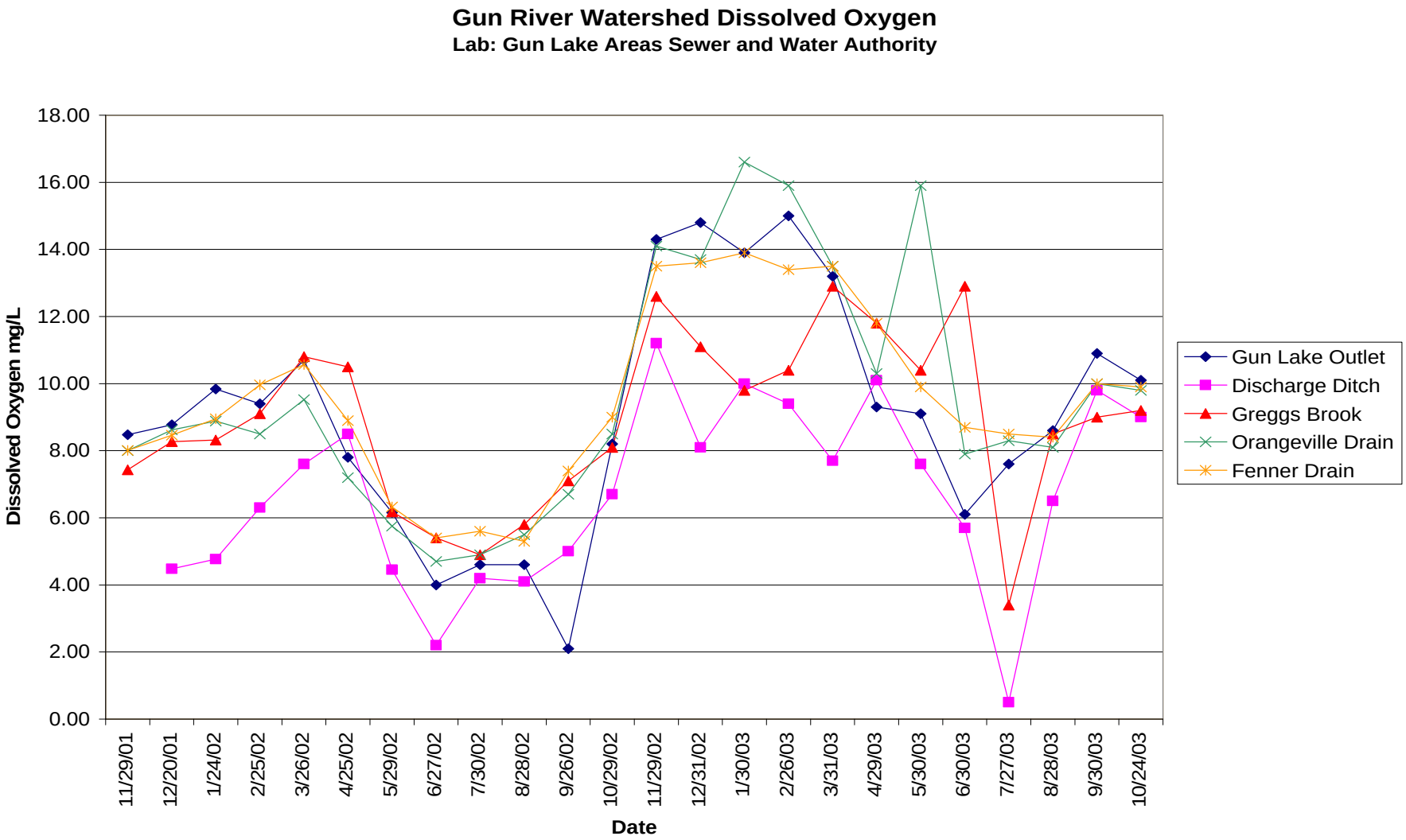
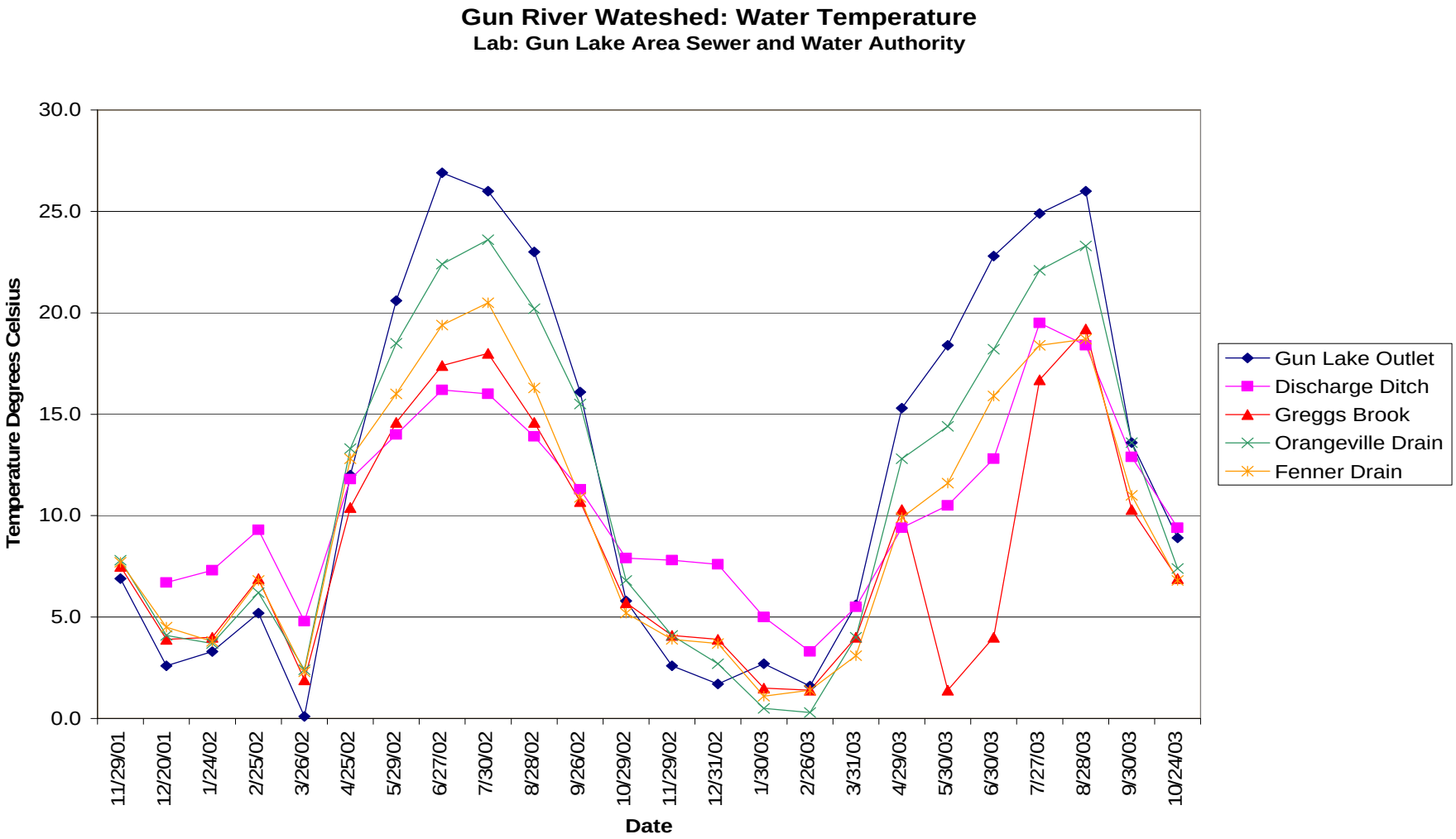


Chart 4.3 - Gun River Water Temperature



4.1 WATERSHED INVENTORY

4.1.1 METHODOLOGY

An assessment of the condition of the Watershed is most accurate when conducted by visual, in-the-field observation. The Watershed was field inventoried to identify NPS pollution sites during the months of July through November 2001. The Gun River was canoed from the Gun Lake dam to the southernmost bridge at 107th Avenue, before the outlet to the Kalamazoo River. All tributaries to the Gun River were walked, where shallow enough, heading upstream so as not to disturb the sediment and decrease visibility.

At each site where a pollution problem was evident, a data sheet was completed. Basic information was recorded about the size of the stream, surrounding land use, buffers, and weather conditions. Seven categories were described on the sheets: debris and trash, construction sites, stream crossings, rill and gully erosion, tile outlets, streambank erosion, and other. Within each category, characteristics were described, which could be used to group and rank these sites. Sample inventory forms are provided in Appendix 2. Each site was recorded geographically with a Global Positioning System unit, when available, or drawn on a map. A photograph was taken at each site.

The sites were numbered for field inventory using a code that consisted of four parts. The first part was based on the EPA's Reach File 3 numbering system. Streams that were not numbered by the EPA were given a number based on the major tributary it fed into plus an extension number. For example, a unnumbered stream that flowed into reach number 867 could be numbered 8671. Unnumbered streams were given extension numbers in a consecutive manner heading upstream. The second part of the site number was the first three letters of the township. The third portion was the two digit section number. The final part was a two digit number indicating the sequence in which the sites were investigated on that reach. For example, the first site on reach 234 in Martin Township, Section 22, would be numbered 234MAR2201.

The data was verified and checked for inconsistencies, then converted to a DBF(IV) file and entered as a point file into ArcView 3.2 Geographic Information System (GIS). Figure 12 displays the sites that were identified as contributing NPS pollution as points on the map. The photographs of each site were linked to the points. The data was sorted by category and ranked according to severity as recorded on the data sheets.

All the road/stream crossings were inventoried according to the MDEQ procedures. The standard MDEQ stream crossing data sheets were used to document the physical and habitat conditions as well as surrounding land use and cover on both the upstream and downstream sides of the road. Examples are included in Appendix 2. Digital photographs were taken facing both upstream and downstream from the crossings.

4.1.2 FINDINGS

Using the characteristics within each category, the sites were ranked by severity (Table 4.3). Multiple characteristics could be recorded at each site. The most sites identified in a category in the Watershed was streambank erosion, with a total of 54 sites. The majority of the sites had mostly bare banks. Stream crossings were characterized with erosion at 42 sites. Problems were mainly due to degraded condition of the structure, flow blockage, or embankment erosion. Many of the 33 sites in the debris category were log jams, which blocked flow or diverted water to cause erosion. Two major types of problems were associated with the 32 sites in the tile outlet category: erosion and discharge. The placement of the tile outlet causes erosion if the outlet is too high causing splash pools and eddy currents. Some outlets were discharging water with unnatural color and odor. The 23 sites in the rill or gully erosion category occurred predominantly in agricultural areas. Some erosion was the result of improperly functioning culverts or tiles, and many gullies were contributing large amounts of sediment.

Table 4.3 - Summary of Inventory Data in the Gun River Watershed

Sources of Pollutants	Characteristic	Number
Streambank Erosion	Total	54
	Washout	13
	Mostly bare bank	27
	> 100'	13
Crossings	Total	42
	Condition = poor	9
	Condition = fair	11
	Erosion = severe	10
	Erosion = moderate	8
	Erosion = minor	12
Debris	Total	33
	Extensive	5
	Moderate	12
	Slight	16
Tile Outlets	Total	32
	Eroding	15
	Discharge color	2
	Discharge odor	2

Table 4.3 - Summary of Inventory Data in the Gun River Watershed

Sources of Pollutants	Characteristic	Number
Upland Source	Total	27
	Crop related	19
	Livestock related	3
	Residential related	3
Rill And Gully	Total	23
	>10' long	16
	>2' wide	10
	>2' deep	8
Livestock Access	Erosion	1
Other	Construction sites	1
	Zebra mussels	1
	Hydrocarbons	2
	Foamy water	1
	Wetland destruction	1
	Unknown source	2

Other problems that could not be specifically included in any one category are summarized under the "Other" category. Items in this category included construction sites that were not adequately controlling for erosion and sedimentation under Part 91 Act 451, PA 1994. Present soil erosion and sedimentation control (SESC) regulations requires the use of proper SESC management practices. Additional items in the "Other" category were leaking fuel tanks on irrigation pumps and the spread of exotic or invasive species. More details about the location and description of these sites can be found in Chapter 5.

4.2 HYDROLOGIC AND HYDRAULIC ANALYSES

4.2.1 INTRODUCTION

Hydrologic and hydraulic analyses were performed for the Gun River in Allegan and Barry Counties as an additional study component of the Gun River Watershed Management Plan. An understanding of the hydrologic and hydraulic characteristics of the Gun River Watershed (Watershed) is consistent with the goal of reducing nonpoint source pollution. The information provided by this study is related to nonpoint source pollution issues in the following ways.

- Determination of the 100-year floodplain will reduce the risk of new development locating not only buildings, but septic systems and other potentially hazardous facilities where they may be inundated by flood waters, thus causing health concerns and/or transport of the associated pathogens/toxics.

- Storm water design criteria adapted at the county level that incorporates stream protection volume for all headwater streams based on numerous urban storm water studies and supported by the conclusions of this analysis, will help maintain more stable channel forming flows and reduce the amount of sediment deposited in the waters of the state from accelerated streambank erosion.

- An understanding of the hydrology of a watershed, the hydraulics of a river or stream and the effects that proposed land use changes and Best Management Practices (BMPs) may have on flow rates, volumes, and velocities is directly related to surface water quality by virtue of maintaining the dynamic equilibrium of the stream and preventing degradation of the water body.

4.2.2 METHODOLOGIES

Hydrologic analysis is performed using a computational model to determine storm water discharges from individual subbasins for various frequency rainfall events. The software used for the hydrologic model is the U.S. Army Corps of Engineers program HEC-HMS. This program computes subbasin hydrographs (a relationship between flow rate and time for a particular rainfall event), which are used as inputs into a hydraulic model to compute river hydrographs, flow velocities, and water surface elevations. The initial analysis is completed based on current land use conditions in the Watershed. Storm water detention alternatives to minimize negative impacts from projected future land use changes are also evaluated.

Hydraulic analysis is performed to predict flow rates, velocities, and water surface elevations in a river. This analysis uses the U.S. Army Corps of Engineers computer program HEC-RAS. The recent release of this computer program is able to model time varying flows. Instead of using steady state flow rates based on peak hydrograph values from the hydrologic analysis, this version of the program takes the subbasin hydrographs, as determined by HEC-HMS, and accurately combines and routes the hydrographs in a downstream progression along the river system. The model is also able to account for available storage in the floodplain.

4.2.3 HYDROLOGIC ANALYSIS

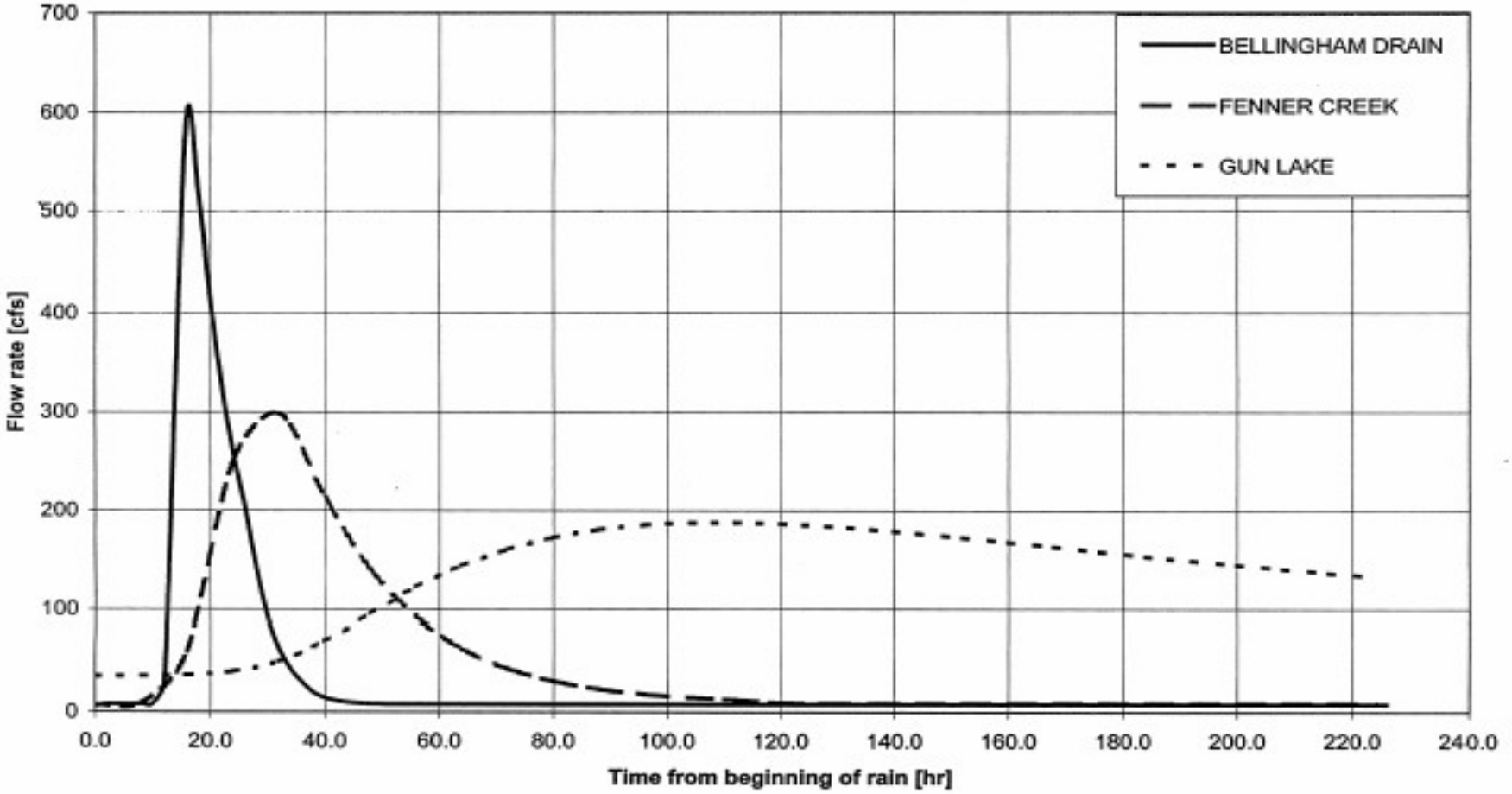
Overall, the Gun River appears to be a relatively stable channel due to the “non-flashy” nature of the Watershed as a whole. Annual maintenance due to fallen trees and log jams is ongoing, but not found to be excessive.

The upper portion of the Watershed, which drains into Gun Lake, is characterized by residential and recreational uses. Future development in this area will have minimal impact on the Gun River because of the storage available in Gun Lake. The middle portion of the Watershed is characterized by agricultural

uses. Significant runoff volumes enter the Gun River by way of three major tributaries: Greggs Brook, Orangeville Drain, and Fenner Creek. Peak flows from these three tributaries have been known to back up into the upper portion. Here there has been a trend toward fallow/open land uses which should result in lower flow rates. The lower portion of the Watershed in Otsego and Gun Plain Townships is characterized by increasing urban development as indicated in future land use plans, although urban sprawl is occurring throughout the watershed. This development could have a significant impact on the amount of runoff entering the Gun River.

Hydrographs from three of the subbasins are compared in Chart 4.4 to highlight the differences in their hydrologic response: Gun Lake basin (at Gun Lake Dam outlet), Fenner Creek, and Bellingham Drain. Gun Lake basin is the largest of the 12 subbasins and therefore releases the largest volume of water. As a result, the area under the hydrograph is the greatest for this subbasin. Storm water draining from the Gun Lake basin is stored in Gun Lake and then released slowly due to the controlling effect of Gun Lake Dam. The peak flows, therefore, occur later and storm water is released over a longer period of time. The center of the Bellingham subbasin is closer to the Gun River than the center of Fenner Creek. Bellingham therefore has a shorter time of concentration resulting in an earlier peak in the hydrograph. The water draining from Bellingham is released more quickly than any of the other subbasins resulting in a higher peak flow rate.

Chart 4.4 - Hydrographs for 100-Year Storm



Comparisons of existing and future flow rates show the impact of development in the lower part of the Watershed. The peak flow rates in the Gun River for a 25-year storm could be expected to increase by 9% and runoff volumes by 3%. Without effective storm water management measures, these increased flow rates and volumes will increase flood elevations in the Gun River. A storm water detention policy release rate restriction of 0.06 cfs per acre would keep the post development flows and water surface elevation at approximately the same levels as predevelopment for a 25-year flooding event (Table 4.4).

Table 4.4 - Hydrologic Model Results - Future Land Use Conditions (25-Year)

	25-Year Peak Flow Rate [cfs]			Runoff Volume [acre-ft]		
Subbasin Name	Existing Conditions	Future Conditions	% Change	Existing Conditions	Future Conditions	% Change
Gun Lake Basin	340	340	0	3,533	3,533	0
Gun Dam	115	115	0	581	581	0
Greggs Brook	234	234	0	1,033	1,033	0
Orangeville Drain	167	167	0	1,436	1,436	0
Fenner Creek	166	166	0	784	784	0
Culver Drain	169	169	0	664	664	0
Sutherland Drain	259	291	+12%	725	763	+5%
Monteith Drain	106	125	+18%	848	904	+7%
Otsego-Plainwell	208	280	+35%	1,295	1,519	+17%
Scott-Whitcomb Drain	122	164	+34%	751	833	+11%
Bellingham Drain	304	366	+20%	583	623	+7%
Reno Drain	239	239	0	1,178	1,178	0
Total for Gun River	**1,412**	**1,537**	**+9%**	**13,411**	**13,829**	**3%**

4.2.3.1 STREAM PROTECTION

In the previous section, storm water detention is proposed for flood control. Storm water detention can also be used for protecting the stream banks during more frequent events. This usually requires designing the detention facility with multiple release rate criteria. Analysis completed using the Gun River model indicates that if the only release criterion is the 0.13 cfs per acre proposed for flood protection, peak flow rates and volumes will still increase during the 2-year bank full storm.

Results of the future land uses analysis are illustrated in Charts 4.5 and 4.6, which compare flow rates along the entire length of the Gun River under existing and future conditions for both the 25-year and the 2-year rainfall events. This figure shows the peak flow rate at each location along the length of the Gun River. Higher flow rates occur closer to the confluence with the Kalamazoo River. The flow rate jumps occur at the locations where the major tributaries feed into the Gun River.

Chart 4.5 - Existing and Future 25-Year Flow Rates

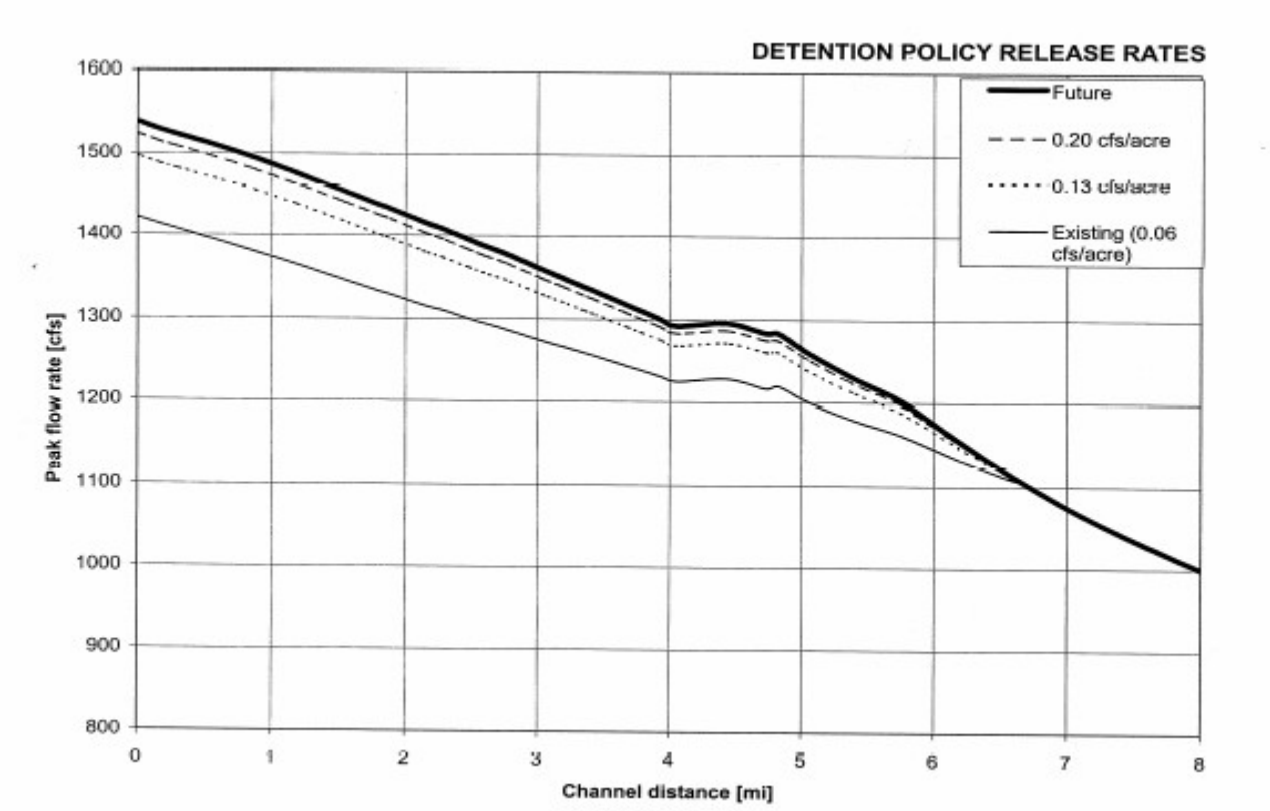
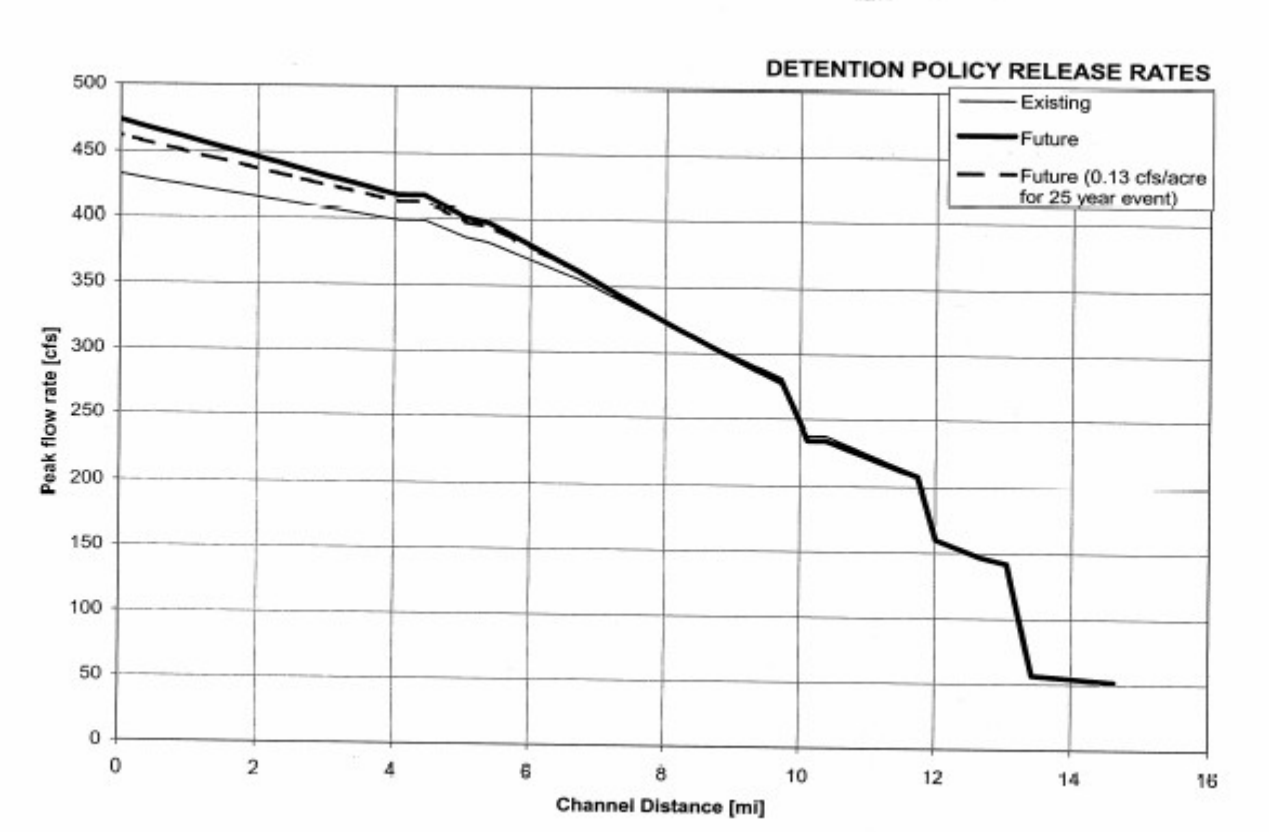


Chart 4.6 illustrates where the peak flow rates do not return to predevelopment levels under the 0.13 cfs/acre requirement established for flood protection. To provide for stream bank protection, a second set of detention requirements is needed. An important part of these detention criteria is controlling storm water volume and flow rate which are directly related to sediment transport and shear stress on the channel bank.

Chart 4.6 - Existing and Future 2-Year Flow Rates



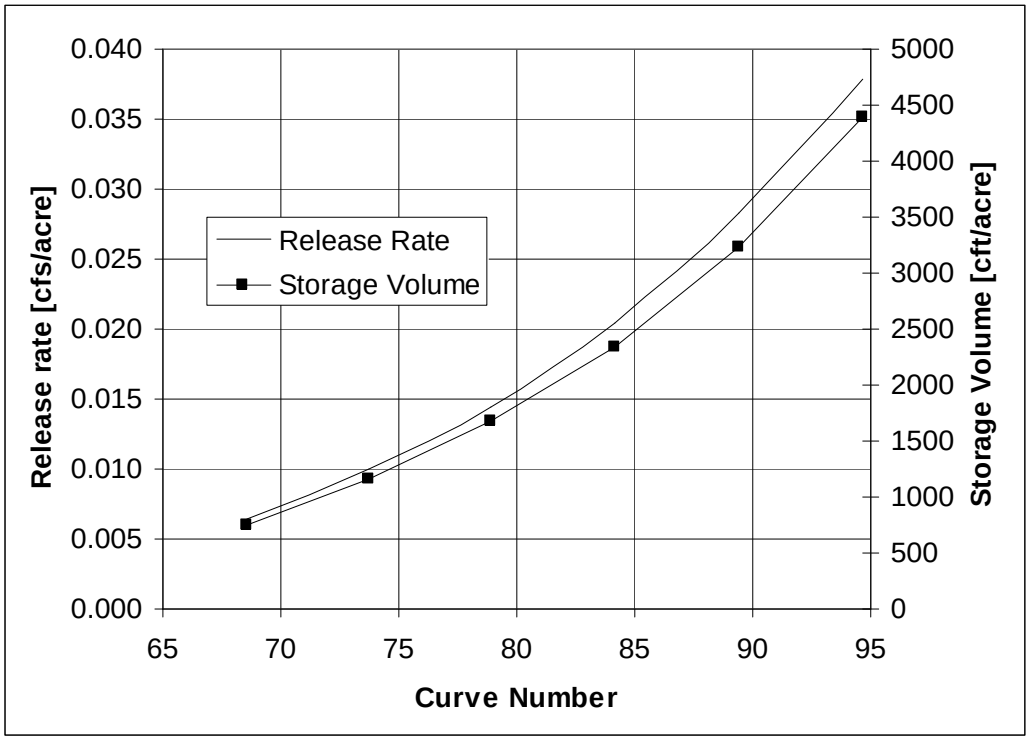
Several methods have been proposed for establishing criteria for stream protection. One method is “two year control” where the post-development peak discharge rates are held to the pre-development rates for the two-year event. Some studies have indicated that this method may actually exacerbate erosion since banks are exposed to erosive velocities for a longer duration. Another approach, where infiltration is not feasible, is to design the detention facility to hold the 1 to 2 year event for a period of 24 hours (i.e. there should be a 24-hour lag between the centriods of the inflow and outflow hydrographs). This extended detention approach releases the runoff in such a gradual manner that critical erosive velocities would seldom be exceeded in downstream channels.

FTC&H has done extensive detention basin modeling to establish release rate criteria for stream protection. A stream protection release rate has been determined which, if used, will detain the 1.5- year runoff for the required 24 hours. The results of this work has been used to establish storm water detention rules for neighboring counties. A detailed description of this work can be found in Appendix 6 of the *Gun River Watershed Hydrologic and Hydraulic Study* report.

This release rate needed for stream protection is a function of the soil type in the drainage area and the degree of imperviousness in the associated development. Release rates restrictions and required detention storage volumes can be expressed in several ways and at several levels of detail. Chart 4.7 shows the release rate (in cfs/acre) and required storage volume (in ft^3 /acre) as a function of the developed Curve Number. An alternative to this gives the release rate as a function of the hydrologic soil group and the number of impervious acres in the development. This approach applied to Allegan county gives the following results:

- Hydrologic soil group A: 0.026 cfs and 3,000 ft^3 storage per impervious acre.
- Hydrologic soil group B: 0.034 cfs and 4,000 ft^3 storage per impervious acre.
- Hydrologic soil group C: 0.051 cfs and 5,800 ft^3 storage per impervious acre.
- Hydrologic soil group D: 0.059 cfs and 5,800 ft^3 storage per impervious acre.

Chart 4.7 - Release Rate as a Function of Curve Number



A third method assumes that developments with A and B soils will use infiltration to reduce peak flows. Using the lower release rate for soil groups C and D gives a value of 0.05 cfs per impervious acre along with 5,800 ft^3 of storage per impervious acre. It should be noted that runoff from the pervious portion of

the development is still included in the volume recommendations above. This approach just uses the number of impervious acres to predict the volume needed to detain runoff from the entire site.

All of these methods are fully explained in the *Gun River Watershed Hydrologic and Hydraulic Study* report.

4.2.4 HYDRAULIC ANALYSIS

The hydraulic analysis provides predictions of river hydraulic characteristics (i.e., flow rates, water surface elevations, velocities, etc.) during storm events. The calibrated model was used to predict the flow rates and water surface elevations for the 2 -, 5-, 10-, 25-, 50-, and 100-year flood events. The peak flow rates, maximum water surface elevations, average channel velocity, flow area, and water surface top width computed for each of these events at the Gun River cross-sections surveyed in 1985 and 2001 were tabulated. The results provided the flood profiles for the 10-year through 100-year rainfall frequencies and the 100-year flood hazard zones for the Gun River.

Flooding is expected on the approaches at 9th Street and 106th Avenue during the 100-year event. This has the potential of causing damage or increasing maintenance of these road surfaces. None of the other publicly owned bridge or culvert crossings are predicted to be overtopped.

The Allegan County Land Information Services (LIS) department provided detailed maps of elevations within the flood hazard zone to be used for future mapping and planning projects.

The road crossings that are expected to flood during a 100-year event are 9th Street and 106th Avenue by 0.2 feet and 0.3 feet, respectively. In both cases the flows will pass over the approach road. The farm lane south of 122nd Avenue also shows overtopping by 0.6 feet.

It is apparent from the water surface profiles that the culverts at 116th and 118th Avenues cause the greatest rise in water surface elevations and directly impact the predicted elevation of the floodplain upstream.

4.2.5 BENEFITS OF THE STUDY

The primary benefit of this study is the following information provided through the analysis, which can be used by decision makers in the Watershed.

- In regard to county storm water design criteria, a storm water detention policy release rate restriction of 0.06 cfs per acre was determined to keep the post development flows and water surface elevations at the same levels as predevelopment for a 25-year flooding event. The analysis was completed for development in Gun Plain and Otsego Townships and the City of Plainwell only, based on future land use maps.

  Follow up: Re-zoning for urban development us actively taking place in Martin Township. The Allegan County Drain Commissioner is considering updates to county standards that call for a detention basin release rate of 0.13 cfs/acre for a 100-year storm. A special policy statement for the Gun River Watershed could be included.

- Analysis performed assuming a 0.13 cfs acre detention basin release rate during a 25-year storm, (based on anticipated Allegan County standards) indicated that peak flow rates and volumes increase during a 2-year "bankfull" event. Therefore, stream protection volume requirements should also be incorporated into the county's rules. One suggested method, for circumstances where infiltration is not possible, is based on routing runoff from a 1.5-year storm through a detention basin and detaining it for 24 hours.

  Follow up: Draft rules of the Allegan County Drain Commissioner contain provisions for stream protection volume.

- The HEC-RAS model may be used to evaluate improvements to hydraulic structures, construction or removal of levies (spoil banks), and other proposed scenarios. Base flows and peak flow rates for a range of storm frequencies are provided for use in sizing hydraulic structures (bridges, culverts, and weirs) in accordance with county drain and the Michigan Department of Environmental Quality (MDEQ) requirements, or for sizing certain streambank stabilization or fish habitat structures.

  Follow up: Specific scenarios have already been requested by local engineering firms, and the model has been modified for use in these independent projects to evaluate the impact of various landform changes on the system hydraulics. Results will be used to obtain regulatory permits for proposed developments.

- The map of flood hazard zones may be integrated with the Allegan County LIS, and used to regulate development within the floodplain. Maps are provided as Figures 8A-8F.

- This work may be used to expedite regular participation in the Federal Emergency Management Agency (FEMA) Flood Insurance Program for Otsego and Gun Plain Townships through a partnership between Allegan County and FEMA. At a minimum, this information should be provided to FEMA when Allegan and Barry Counties are scheduled for floodplain map updates as part of FEMA's Floodplain Mapping Update Program.

4.2.6 CONCLUSIONS OF THE STUDY

Conclusions from the Hydrologic and Hydraulic (H&H) Analysis of the Gun River are be summarized as follows:

- Overall, the Gun River appears to be relatively stable due to the "non-flashy" nature of the Watershed.

- The hydrology of the Watershed is such that development upstream of Gun Lake will have minimal impact of the Gun River due to the large amount of storage available in Gun Lake. Low, broad hydrographs are characteristic of the discharge from Gun Lake (i.e., the upper watershed).

- The most significant contribution to the Gun River downstream of Gun Lake is via three major tributaries that enter at about midpoint along the Gun River. The large contribution of discharge from Greggs Brook, Orangeville Drain, and Fenner Creek will actually cause reverse flow in the upper portion of the Gun River during flood events. However, the land use trend over the last 40 years (as indicated on land cover maps) has been from intense agricultural use toward more fallow and open space, which would tend to result in lower runoff rates and volumes.

- A storm water detention policy release rate restriction of 0.06 cfs per acre was determined to keep the post development flow and water surface elevation at the same levels as predevelopment for a 25-year flooding event.

- Storm water runoff criteria that control larger flood event (25-year storm) are not effective for controlling smaller channel forming flows (2-year storm). Therefore, separate design criteria are needed to protect the tributary streams form new developments.

- The most significant changes in land use between existing zoning and future land use plans are in the lower portion of the Watershed in Otsego and Gun Plain Townships. However, urban sprawl is occurring throughout the Watershed regardless of current zoning that indicates an agricultural use.

- The only structures that would be expected to overtop during the 100-year flood are the approaches to the bridges at 9th Street and 106th Avenue. However, it is apparent from the water surface profiles that the culverts at 116th and 118th Avenues cause the greatest rise in water surface elevations and directly impact the predicted elevation of the floodplain upstream.

It is important that this effort on behalf of the Gun River not stop here if water resource goals are to be met for both the Gun River and Lake Allegan, which has a Total Maximum Daily Load for phosphorous. Implementation of low impact development techniques should be pursued along with quantitative storm water design criteria for flood control, which is substantiated by the modeling performed during this study. BMPs for water quality should be included in county storm water rules and township land use ordinances.

4.2.7 STEERING COMMITTEE INPUT

The Steering Committee has expressed a desire to do everything possible from a urban development perspective. Examples include educating developers and city/township review officials in low impact development techniques. Provisions to allow for low impact development storm water criteria could be included in county storm water rules and township land use ordinances to maintain as close as possible the pre-development hydrology of the site for water quality and stream protection. Provisions should also allow for cleansing overbank or flood flows in the natural watercourses without increasing flooding.

4.3 DESIGNATED USES

The following eight designated uses have been identified by the State of Michigan for all waters of state to meet.

- Agricultural use
- Public water supply at point of intake
- Navigation
- Warmwater fishery/coldwater fishery
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31
- Industrial water supply

These designated uses provide a starting point for discussion about the goals for the Watershed project. The Steering Committee evaluated the MDEQ's designated uses for all surface waters and determined the designated uses that were of concern to the Watershed. The following descriptions of all the designated uses clarify their importance to the Watershed.

4.3.1 AGRICULTURAL USE

Surface waters must be a consistent and safe source for irrigation and livestock watering. Irrigation is important in areas of the Watershed that have very well drained soils. Livestock producers in the Watershed rely on water that is free of pathogens that could pose health risks to the livestock.

4.3.2 PUBLIC WATER SUPPLY AT POINT OF INTAKE

Municipal water supplies must have safe and adequate amounts of surface water. No surface water intakes for municipal water supplies exist in the Watershed, therefore this designated use is not addressed.

4.3.3 NAVIGATION

Reaches of waterways that are large enough for canoes or kayaks must maintain navigable conditions. Recreational users should be able to enjoy a float down the Gun River without experiencing excessive log jams, low footbridges, and other obstructions that impede navigation.

4.3.4 WARMWATER FISHERY

A warmwater fishery is generally considered to have summer temperatures between 60 and 70 degrees Fahrenheit and is capable of supporting warmwater species, such as largemouth and smallmouth bass, on a year-round basis. The MDNR has stocked both the Gun River and Gun Lake with varieties of fish for many years to sustain and improve the fisheries in the area.

4.3.5 COLDWATER FISHERY

A coldwater fishery is considered to have summer temperatures below 60 degrees Fahrenheit and to be able to support natural or stocked populations of brook trout. The MDNR has stocked the coldwater reaches of the Gun River to sustain and improve the fisheries. A healthy riparian habitat is essential to provide the needed shade to the streams to maintain lower temperatures.

4.3.6 OTHER INDIGENOUS AQUATIC LIFE AND WILDLIFE

Aquatic plants and animals and other wildlife in the ecosystem should be considered in all management strategies. A stable and healthy habitat supports populations of wildlife that provide the outdoor recreational opportunities in the Watershed.

4.3.7 PARTIAL BODY CONTACT RECREATION

Water quality must meet standards of less than 1,000 count/100 mg of *E. coli* for recreational uses of fishing and boating, where complete submersion in the water is unlikely, to be safe. The popularity of fishing and boating in the Watershed necessitates the prevention of *E. coli* from entering the waterbodies. *E. coli* levels in some agricultural areas have exceeded water quality standards.

4.3.8 TOTAL BODY CONTACT RECREATION

Water quality must meet standards of less than 300 count/100 mg of *E. coli* for areas to be safe for swimming. Other impediment to total body contact recreation include nuisance aquatic vegetation and algae blooms from excessive nutrient loadings to the Watershed.

4.3.9 INDUSTRIAL WATER SUPPLY

Industrial water supplies must have cool water with low turbidity. No surface water intakes for industrial water supplies exist in the Watershed, therefore this designated use is not addressed.

Table 4.5 described the status of each designated use in the Gun River Watershed.

Table 4.5 - Impairments and Threats to Designated Uses

Designated Uses	Status of Designated Use
Agriculture	Impaired by sediment, obstructions, *E. coli,* hydrology, and invasive and exotic species
Warmwater fishery	Impaired by sediment, hydrology, temperature, and nutrients
Coldwater fishery	Impaired by sediment, nutrients, hydrology, and temperature
Other indigenous aquatic life and wild life	Impaired by sediment, nutrients, hydrocarbons and other contaminants, invasive and exotic species, and habitat fragmentation
Partial body contact recreation	Impaired by nutrients, obstructions, and *E. coli*

Table 4.5 - Impairments and Threats to Designated Uses

Designated Uses	Status of Designated Use
Total body contact recreation	Impaired by nutrients and *E. coli*
Navigation	Impaired by hydrology and obstructions
Industrial supply	Not a use
Public water supply	Not a use

4.4 DESIRED USES

The Steering Committee members identified desired uses, which are other ways in which the Watershed is used and additional opportunities for the Watershed to provide in the future. These desired uses can be implemented through community efforts and partnerships to gain support for and increase the stewardship of the Watershed.

4.4.1 GROUNDWATER PROTECTION FOR DRINKING WATER

Most residents in the Watershed rely on private wells for drinking water. The Allegan County Health Department has recorded high levels of nitrates in a few residential wells in the Watershed. Protection of groundwater use for a private drinking water source is important to the residents in the Watershed.

4.4.2 INCREASE RECREATIONAL OPPORTUNITIES

Gun Lake is a popular destination for water sports in the summer months. Yankee Springs Recreation Area is also popular for its trails, which outdoor enthusiasts can enjoy in all seasons. Canoeing is popular along the lower reaches of the Gun River. Providing new, stabilized access points, one of which is “barrier free,” would make canoeing safer and more enjoyable.

4.4.3 PRESERVE OPEN SPACE AND RURAL CHARACTER

Allegan and Barry Counties are experiencing rapid growth. Plans need to be put in place now to determine the future state of these counties to manage the growth. Townships are investigating techniques to preserve open space and maintain the rural character that makes them attractive to those relocating to the area. Workshops and educational programs about tools that Townships can use to manage growth should be organized and officials should be encouraged to attend.

4.4.4 CREATE A GUN RIVER TRAILWAY

The Kalamazoo River Valley Trailway borders the Kalamazoo River, offering the public a place to walk, run, or bike along the river bank. A trail along the Gun River could offer the same opportunities to the Watershed community. Interpretive signs could be added at strategic locations to inform the users of the interesting features of the area.

4.4.5 PROTECT PRIME FARMLANDS

The Watershed has been extensively drained in the past for agricultural use. The prime farmland soils in this area have formed the solid base for the rural character of the Watershed, and the economic base from which many earn their living. The Watershed is a key location for development, with easy access from U.S. 131 and situated between the Cities of Grand Rapids and Kalamazoo. Community planners need to put a value on this prime farmland and institute policies that will protect this land for future generations.

4.4.6 PROTECT UNIQUE HABITATS FOR ENDANGERED SPECIES

Natural Features Inventory (NFI) of the Watershed identified areas where a threatened, endangered, or special concern species or habitats have been found. These areas of element occurance are shown as ”EO” on Figure 8. The protection of these areas, most of which are in the Yankee Springs Recreation Area, is important to maintain the integrity of diversity in the Watershed.

4.4.7 ENCOURAGE WILDLIFE HABITATS

Programs exist that can assist landowners and agencies to preserve and enhance habitats for wildlife. Local decision-makers must be educated about these programs and have the tools available to promote these programs and encourage landowners to participate. The United States Department of Agriculterure (USDA) Conservation Reserve Program (CRP) will provide technical assistance and funding to restore habitats on agricultural lands. The Southwest Michigan Land Conservancy can acquire land or negotiate permanent easements to protect the land in the future. The Conservation Districts have access to many programs that can be implemented on smaller, residential properties.

4.5 SOURCES AND CAUSES OF POLLUTANTS AND IMPAIRMENTS

4.5.1 POLLUTANTS AND IMPAIRMENTS

The pollutants that are impairing the designated use of agriculture in the Watershed include sediment and *E. coli.* Altered hydrology and invasive species are also impairing agricultural use. Navigation is impaired by obstructions and altered hydrology. Sediment and nutrients are the pollutants impairing the designated use of warm and coldwater fisheries. Altered hydrology and increased temperatures are also degrading the fisheries habitat. The MDEQ biological survey conducted in 1999, as noted in Chapter 2, rated the macroinvertebrate community at two locations as poor due to channel manipulation, sedimentation, and embedded substrate. The Steering Committee determined that the designated use of other indigenous aquatic life and wildlife is impaired by sediment and nutrients. Pollution from hydrocarbons and other contaminants are also impairing the natural environment. Invasive species and the fragmentation of habitats are harming wildlife populations. Partial and total body contact recreation are impaired in Gun Lake and Gun River by excessive nutrients and *E. coli.* Partial body contact recreation on Gun River is also impaired by obstructions and altered hydrology.

4.5.2 SOURCES AND CAUSES

The sources of pollutants and impairments were determined through the watershed inventory and information from previous studies. The reduction of pollutants requires the knowledge of where the pollution originates in order to apply the appropriate remedy. The causes of the sources of the pollutants and impairments were determined through field observations and the analysis of the hydrology. The identification of the causes of the sources of pollution direct the focus of the remediation efforts on the condition that is creating the impairment to the designated use. This guidance ensures that the most appropriate designs and effective control measures are implemented or installed.

The investigation of the Watershed found that sources of sediment entering the Gun River included agricultural operations, road/stream crossings, rill and gully erosion, streambank erosion, livestock access sites, erosion at tile outlets, and a few construction sites. The causes of the sources include conventional tillage, lack of filter strips, undersized culverts with steep side slopes and degraded bridges, obstructions in the stream channel, flashy flows, improperly installed tiles, and ineffective SESC measures. Estimated sediment loss from agricultural areas was calculated using Michigan State University's *"RUSLE - Online Soil Erosion Assessment Tool".* The estimated soil loss from NPS sites was calculated using MDEQ's *"Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual."* The

total soil loss estimated for the Gun River and its tributaries was 43,554 tons/year, or 1.7 tons/acre/year. The estimated soil delivery to the Gun River and its tributaries was 21,848 tons/year, or 0.08 tons/ac/year.

The suspected sources of sediment for Gun Lake is urban runoff from impervious surfaces and landscaped shoreline properties.

Nutrients in the Gun River are originating from agricultural operations, residential lawns, and dumping of yard wastes. Improper use and application of fertilizers on cropland and lawns cause excessive nutrients to enter the waterways. The lack of composting and knowledge of how yard wastes add nutrients to surface water results in illegal dumping of yard waste into streams. Estimated phosphorus and nitrogen deliveries from agricultural areas and NPS sites were calculated using MDEQ's *"Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual."* The total phosphorus delivery estimated for the Gun River and its tributaries was 41,440 pounds/year, or 1.6 pounds/acre/year. The Kalamazoo River/Lake Allegan TMDL predicted the annual phosphorus loading to the Gun River, using a model, to be 11,119 pounds/year. The total nitrogen delivery estimated for the Gun River and its tributaries was 82,891 pounds/year, or 3.2 pounds/acre/year.

Suspected sources of nutrients in Gun Lake include urban runoff from pet waste and populations of geese.

The hydrology of the Watershed has been altered by the drainage networks and the changes of land uses within the Watershed. The establishment of drains and traditional maintenance techniques of drain improvements have changed the natural hydrology of the Gun River system. The conversion of wetlands into other land uses and the increase of impervious surfaces in the Watershed result in greater volumes of runoff and decreased infiltration of storm water.

Natural materials, such as trees and logs, are the most common sources of obstructions in the Watershed. Discarded appliances, construction materials, and accumulations of trash are also obstructing flow and navigation.

E. coli is spread through the feces of warm blooded-animals, and its detection often indicates that other dangerous bacteria are present. Livestock with access to streams, large populations of wildlife, failing septic systems, and inadequate manure storage facilities are sources of *E. coli*. The lack of fencing along streams to keep out livestock allows waste to enter the stream. Poorly sited and maintained septic systems and manure storage facilities also release *E. coli.* Leaching or overflowing manure storage areas and improper land applications of manure can also add bacteria to the stream.

Stream temperatures increase from surface runoff, low base flows, and lack of riparian habitat. Increases in impervious surfaces in the Watershed cause an increase in surface runoff, especially from heated surfaces, such as parking lots and rooftops. Excessive irrigation in the Watershed results in low base flows in many areas. Removal and lack of preservation of stream side vegetation prevents a healthy riparian habitat.

Hydrocarbons were observed entering the Gun River from irrigation pumps and other machinery along its banks. Old, leaking, and inefficient machines allow petroleum by-products to enter the watercourse.

Boats, vehicles, and animals entering the Watershed from other areas have introduced invasive species. Zebra mussels, purple loosestrife, and Eurasian watermilfoil have been found in the Watershed. The spread of these invasive species is often caused by unstable or disturbed land being susceptible to the invasion.

A more detailed description of the connection between the designated uses, pollutants, and impairments, and sources and causes is provided in the Water Quality Statement included in the Chapter 7.

CHAPTER 5 - CRITICAL AREAS AND NONPOINT SOURCE POLLUTION

5.0 CRITICAL AREAS

After identifying major sources of pollution or impairments in the Gun River Watershed (Watershed), the Steering Committee's focus was narrowed to the areas that contribute the majority of those sources. Focusing on these "Critical Areas" prioritizes concerns and results in the greatest improvements for the time and money invested into the project. These critical areas delineate the geographic limits where the implementation of Best Management Practices (BMPs) will be targeted.

The Steering Committee identified the critical areas of the Watershed using information from the field inventory, estimates of pollutant loads and deliveries, and the designated/desired uses of the Watershed. The condition of the streams and sources of impairments were assessed through the field inventory. Areas with active stream erosion, agricultural runoff, rill and gully erosion, tile outlet failure, road crossing erosion, and excessive debris were discussed to rank their priority in the project. The severity of impairments were cataloged into a database used to conclude what areas pose the greatest threat to the health of the Watershed.

The estimates of the pollutant loads and delivery to the stream were based on the information from the field inventory and calculated by subbasin. This information determined the soil delivery, in tons per year, and the phosphorus and nitrogen content, in pounds per year, that each subbasin is currently experiencing.

Based on the complex variety of land uses on diverse topography with many unique ecological features, no one remediation plan can cover all contingencies encountered in the Watershed. As a result, the critical areas are classified into four groups consisting of Agricultural, Residential, Wetland, and Recreational Critical Areas. A map showing the location and type of every critical area can be found in Figure 14.

5.1 DESCRIPTION OF CRITICAL AREAS

5.1.1 AGRICULTURAL CRITICAL AREAS

The agriculture critical area can be divided into two subgroups that each have a unique set of problems. The first group is the conventionally tilled row areas. The major sources of concern in these areas are

runoff and streambank erosion that result in excess amounts of sediment and nutrient loading. Most soils in these areas have a low runoff potential, however, since they are drained through tile systems, peak flows are rapid and sporadic. Bankfull flow levels are not uncommon to the drainage network, and as a result, much of the vegetation has been removed from bank sides allowing for unstable conditions. Once the bank sides become unstable, high flows cause soil detachment, slumping, and outlet failures. Sediment removed from streambanks is usually deposited downstream causing culvert or drain blockage. Blocked culverts and diminished channel capacity exacerbate existing conditions and accelerate erosion downstream. Another source of impairment in this type of agricultural critical area is hydrocarbon contamination from irrigation pumps. BMPs in conventionally tilled soils will focus on filter strips, conservation tillage, cover crops, nutrient management, streambank stabilization, and irrigation pump maintenance.

The second agriculture critical area includes muck soils. Farms in muck areas are characterized by very flat topography in poorly drained areas with a high amount of moderately decomposed organic material. To cope with high water tables, a network of tile drains were created in the early 1900s to speed the drainage of these soils. Without the tile drainage this soil would not be suited for crops. Much of the muck deposits in Allegan and Barry Counties are drained and in production as row crops, specialty crops, or pasture land.

Problems associated with farming in muck soils are ponding, soil blowing, and phosphorus infiltration. Since the water table in this low lying flat topography is very shallow, plugged tiles can quickly turn fields into ponds. When ponding occurs the soils tend to slump, and washouts may occur along drain ditches. Once dry, this soil has such a low organic strength that it can easily be blown away. Another major concern has been the overuse of phosphorus fertilizer in these soils. Phosphorus typically is very readily held in soils. However, overuse of phosphorus in muck, which is easily detached by water and wind, can have detrimental effects when runoff or sediment finds its way into waterways. BMPs in the muck farming areas will be implementing cover crops and windbreaks, removal of obstructions or undersized culverts that are causing flooding, and nutrient management strategies.

Agriculture areas, the largest land use in the Watershed, contribute heavily to the impairments caused by sediment and nutrients. The Orangeville Drain subbasin had the highest estimated soil loss of all the subbasins, followed by the Sutherland Drain and Fenner Creek subbasins. These three subbasins have been recommended as the highest priority agricultural areas in the Watershed. Additionally, a 1/4 mile riparian strip parallel to the top of all streambanks has been identified as a critical area. All farms with soils classified as muck are in the critical area since they are extensively drained and wind can blow sediments for quite a distance.

5.1.2 RESIDENTIAL CRITICAL AREAS

The second critical area category is residential riparian zones. The area encompassing all residential areas within 200 feet from lake shorelines and the top of all streambanks and drainage ditches are included into this critical area. Residential areas are also a large contributor to nutrients and are suspected to be a main source of *E. coli* and other pathogens. Failing or inadequate septic systems are the main sources. Drain fields located in the water table can carry nutrients and *E. coli* directly into surface water. Septic tanks and fields may be at full capacity and leach nutrients into the ground or surface water.

Secondary concerns associated with residential areas are impervious surface runoff, yard waste, and habitat destruction. Unstable hydrology was ranked as the third highest priority impairments by the Steering Committee. Reducing impervious surfaces in residential areas is paramount to managing sporadic flows. Impervious surface runoff from roads and driveways servicing residential developments may also contain hydrocarbons and heavy metals. Runoff from rooftops and parking lots not only contains contaminates, but it has also been warmed by the sun and contributes to thermal pollution. Construction sites need to have management practices that prevent erosion and sediment from entering streams and drains. Yard waste piled on lake shorelines or in streambanks can blow, wash, or be carried by floods into the water adding nutrients and pesticide contaminants. Nuisance populations of geese can quickly create a problem in the summer months when they feed in lawns and gardens. Goose feces, up to four pounds per goose per day, wash into lakes and streams and contribute to nutrient and pathogen impairments.

Nutrients, hydrology, pathogens, hydrocarbons, exotic species, and habitat fragmentation were all priority impairments for the watershed, and are all contributed by residential areas. BMPs in residential critical areas will focus on public education strategies, township planning ordinances, and increased testing for *E. coli* in highly developed areas not being serviced by sewer systems.

5.1.3 WETLAND CRITICAL AREA

“The sole reason to justify the expenditure of tax dollars on the channelization [of the Gun River] in the first place was to render the basin fit for agriculture and to improve the health of people living in the general area surrounding the basin” (O’Meara, 1981). The previous statement is a very good argument for the drain projects that have occurred in the Watershed. Kenneth O’Meara collected quite a number of accounts from presettlement visitors to the Watershed. They describe this area as a virtual jungle of mud, mosquitoes, and dense impassible undergrowth. In 1787, the Northwest Ordinance charged settlers with the call for rendering the wilderness tolerable to humans. Orders were followed by draining wetlands and converting the land to agriculture.

The rich soils in the Watershed are some of the best soils in the state for specialty crops of onions, beets, and celery. To convert this prime farmland back to its original state would most likely cause hardship on those that rely on the farmland. However, those farming have complained about the declining fish populations and flooding that has inundated many crops and homes. This “catch-22” has created a great controversy for those that live in this complex drainage network. The best solution has to be one of compromise.

The reason why drains create a problem for the Watershed is they work, and they work very well. A drain is cut into wetland soil to lower the water table and to speed the transfer of water from the soil to the stream channel. However, when the water runs off at greater volumes and speeds it causes higher peak flows and decreases the infiltration into groundwater. The result is very damaging to the stream hydrology and ecology.

Wetlands contain an abundance of wildlife both above and below the surface. The huge amount of biomass in a wetland is capable of purifying outflow and storing water for a slower release to stream channels and aquifers. Restoring wetlands also has a significant impact on improving fisheries, species diversity, and water quality in the Watershed.

Restoring wetlands should only occur in areas that once were characterized by wetland vegetation, soils, and hydrology. Constructing wetlands in upland areas is not nearly as beneficial as restoring a wetland in its original location. Restoring a wetland is sometimes as simple as plugging drain tiles. Constructing a wetland can be cost prohibitive. The most simple technique to identify prior wetlands is to map the soil characteristics. Soils that were once inundated with water and have a high organic content are called hydric soils. Figure 4 shows the presence of hydric soils in the Watershed.

Wetland critical areas, shown if Figure 14, are those that have hydric soils which are feasible to restore, or have existing wetlands that need preservation. Fields that are problematical for growing crops due to flooding or saturated soils are prime candidates for wetland restoration. The wetland and soils maps are useful guides for planning restoration projects. BMPs in the wetland critical areas will focus on landowner education programs, farmland preservation, and encouraging agricultural growers to enter more land into conservation programs for restoration or preservation.

5.1.4 RECREATIONAL CRITICAL AREAS

The recreation critical areas include Gun Lake, Fish Lake, and a section of the Gun River that will be designated as a recreation reach. Impairments to recreation in these areas are *E. coli*, nutrients, hydrology, and obstructions.

For many people living on the Gun River, canoeing and kayaking are important recreational activities that are impaired by a number of pollutants. Trash, debris, and log jams have made many areas impassible by boaters. Low flows are another problem that hinder canoes and kayaks from using some portions of the Watershed. In these areas irrigation scheduling may become an important tool to restoring stable hydrology and improving base flows. In some cases restoring a wetland would also provide adequate flows to maintain year-round recreational use.

Pathogens and nutrients affect users of Gun Lake and the Gun River. Sufficient testing for *E. coli* has not been complete for most of the Watershed, but it is suggested that more testing be completed in Cuddy Drain and the Gun Lake Public Beach. Nutrients become a problem for boating and swimming when algal blooms degrade water odor, aesthetics, and navigability. Nutrients also contribute to excess aquatic plant growth and organic sedimentation.

Other impairments that may affect a water courses recreational capacity are invasive and exotic species and any impairment that degrades fishery quality. These impairments have not been addressed by the Steering Committee at this time, but may be included at a future date.

Recommended BMPs in the recreation critical area will concentrate on obstruction removal in designated navigation areas, hydrology improvement, and the reduction of pathogens and nutrients.

5.2 PRIORITIZATION PROCESS

The prioritization of the designated uses and impairments of the designated uses was discussed during the Steering Committee meetings on January 17 and February 21, 2002. Pollutants, impairments, and threats to these designated uses were identified for this Watershed through reviewing past studies, sharing local knowledge, and evaluating the results of the Watershed inventory.

5.2.1 METHODOLOGY

The Steering Committee met several times and decided that prioritizing uses would not reflect the purpose of their efforts to protect water quality. All uses of the water resource are important. Some uses are more prevalent than others depending on the subwatershed. For example, total body contact recreation for Gun Lake is a high use, but total body contact recreation is not as high of a use for Gun River in Martin Township. The Steering Committee decided to prioritize the impairments/pollutants with respect to severity and scope. Prioritizing the impairments/pollutants provides a way to focus implementation activities on the most severe problems within the Watershed.

The impairments to the designated uses were prioritized by considering their level of disruption to local water uses as well as existing watershed goals set by the Kalamazoo River Remedial Action Plan and the Total Maximum Daily Load (TMDL) Plan implementation process to remove Gun Lake from the 303(d) non-attainment list. Since the Gun River is in the Kalamazoo River Watershed, it is very important that these existing goals are considered in the prioritization of impairments and recommendations of BMP implementation that will initiate the process to remove Gun Lake from the 303(d) list. With this in mind, sediment and nutrients were considered top priority impairments to water quality. Accordingly, the BMP implementation process will give high priority to any practice that will aid in the TMDL implementation plan.

The watershed inventory, compiled of information about the sites of nonpoint source pollution, collected details about the scale of impairments in each category. Data such as length of gullies, height of streambanks, and amount of debris were used to determine the level of impairment of each site. Sites were then designated as either high, medium, or low priority impairment. For example, a site with severe erosion that is actively depositing sediment might be given a high priority, which would indicate that this site should receive preferential treatment when implementing BMPs. The estimated costs of BMP implementation are calculated in Tables 5.1 through 5.8. Recommendations are based on the information of each site and must be field verified before scheduling BMPs. The information collected provided a method of prioritizing sites and estimating total cost of implementation. Estimated costs are calculated using the known extent of impairment and the "*Building Construction Cost Data*" (RS Means Company, Inc., 1996). Prices reflected in the BMP recommendation tables have been adjusted for estimated prices in the year 2003.

Sites requiring immediate attention were determined to be high priority and scheduled to be completed within 5 years. Those of medium priority were scheduled to be implemented in 5 to 10 years. Those of low priority were scheduled to be implemented in 10 to 20 years. The prices shown in Tables 5.1 through 5.8 reflects estimated total costs for implementing all BMPs in the Watershed regardless of the appropriate funding source. A detailed description of funding opportunities and those responsible for providing financial and technical support can be found in Chapter 9 - Sustainability.

5.3 BMPS FOR NONPOINT SOURCE POLLUTION CATEGORIES

5.3.1 AGRICULTURAL NONPOINT SOURCE POLLUTION

Sediments, nutrients, and pesticides are possible pollutants contained in runoff from agricultural sites. Rather than just installing filter strips to prevent contaminated water from entering drains and streams, it

would be more beneficial to prevent contamination at its source. Buffers will still be incorporated, but they will not be the only BMP relied upon to meet the TMDL and Watershed goals (Table 5.1).

Agriculture NPS pollution is caused by rain or wind detaching loose soil particles and depositing them to drains or streams. The permanent solution is to make the soil stable so that water and wind is unable to transport material to waterways. Not only will this prevent water quality impairments, but it will also provide sustainable agriculture practices to area growers.

Table 5.1 - Agriculture BMP Cost

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
59MAR0301	At 1298	Brown	Rotten eggs	N	AG	AG	Both	Conventional	?	Dairy	Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover, and $58/ac rental	$3,432	H	1298 is 3' thick organic muck, brown/gray conglomerate with methane odor, between pastures
40MAR1201B	122nd Street. crossing	Brown	None	3'-10'	AG	AG	Both	Conventional	None		Conservation tillage[2] BMPs and filter strip[3]	$10/acre till, $190/acre filter, $58/ac rental	$3,110	H	
59MAR0303	East of long barns, 1,000' d/s from 124th	Cloudy	None	N	AG	AG	Both			Dairy	Filter strip[4]	$190/acre filter, $58/ac rental	$2,310	H	
59MAR0301	At 595 outfall	Cloudy	None	N	AG	AG	Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[4]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	595 stagnant, plume into 59, 50' of duckweed up 595
40MAR3608B	2nd Street bridge north of Hooper	Brown	None				Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[5]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	
570MAR2703	Drain inlet east of crossing	Cloudy	None	3'-10'	AG	AG	Right bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[6]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Cloudy/milky water coming from inlet drain.
570MAR2702	Drain inlet at bend in culvert drain	Cloudy	None	3'-10'	AG	AG	Right bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[7]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Evidence of field runoff, picture No.8, water color change, milky water where drain enters
1059GUN1103		Clear	None	N	AG	AG	Left bank	Conventional			Conservation tillage[2] BMPs and filter strip[8]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Picture available, double culvert coming off field w/ little buffer
1059MAR2508	3rd field u/s from 2nd on left bank	Brown	Musty		AG	AG	Left bank	Conventional			Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover, and $58/ac rental	$3,432	H	Dark soil field, small gullies, substrate very mucky, lots of aquatic plants & algae, diverse & prolific pop
59MAR1005	Next to cornfield up from 593	Brown	None	N	AG	AG	Left bank	Conventional / plow perp			Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover, and $58/ac rental	$3,432	H	No buffer at all, some bare to stream, black soils, lots of aquatic vegetation
575WAY3502	By dairy on 4th Street	?	None	1'-3'	AG	AG	Right bank	Grazing		Dairy	Agriculture BMPs [2,4]	$18/yd fence	$9,000	H	Utility box falling in
40MAR3501	200' upstream from 2nd Street. bridge North of Hooper						Left bank				Conservation tillage[2] BMPs and filter strip[8]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Drop inlet opening stable, but field eroding at inlet

Table 5.1 - Agriculture BMP Cost

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
40MAR1301B	120th Avenue crossing	Clear			AG		Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[9]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	M	Left bank downstream road ditch contains field runoff of discolored water
40MAR3502A			None				Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[10]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40GUN0210A	Bridge crossing 2nd Street	Brown	None	>10'			Right bank	Conventional	None		Conservation Tillage[2] BMPs and Filter Strip[11]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40MAR1402B	2nd Street crossing north of 118th.	Brown	None	3'-10'	AG	AG		Conventional	None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Possible runoff from field
40MAR2605							Left bank	Conventional			Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Electric irrigation point
40GUN1001B	110th Avenue bridge	Brown	None	Y			Left bank	Conventional			Conservation tillage BMPs[2]	$10/acre Till	$800	M	Metal retaining wall on right bank, ditch enters from east and irrigation downstream
40MAR2302A			None		AG	Road	Left bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40MAR2603A			None		AG	Road	Left bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40ORA0601B	Patterson Road crossing	Green	None	3'-10'			Right bank		None		Filter strip[3]	$190/acre filter, $58/ac rental	$1,155	M	
40GUN0103B	200' upstream in ditch adj. to corn						Right bank		None		Filter strip[4]	$190/acre filter, $58/ac rental	$1,155	M	
40GUN0103A	200' upstream in ditch adj. to corn						Right bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Corn field adjacent to ditch
RDGUN0101B							Right bank		None		Filter strip[4]	$190/acre filter, $58/ac rental	$1,155	M	
403GUN1604B	600' upstream from Gun on 7th Street	Brown	None	>10'			Both		None		Filter strip[4]	$190/acre filter, $58/ac rental	$2,310	L	

Table 5.1 - Agriculture BMP Cost

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
40GUN1801B	107th Street bridge	Clear	None	Y			Left bank				Conservation tillage BMPs[2]	$10/acre Till	$800	L	

[1]Windbreak assumes 3.6 acres for a 40 acre square field.
[2]Conservation Tillage: No till or minimum till incorporated with well timed fertilizer and pesticide applications, average 40 acres at $10/acre.
[3]Filter strips: For estimations, a standard 1.5 acres for filter strips was assumed, $190/ac for establishment, $58/ac/year rental for 10 years.
[4]Agricultural BMPs: Use of cattle exclusion fences in waterways, average 500 yards, $18/yd.
[5]Estimated cost for establishment and 10-year rental payments.

High priority	$36,446
Medium priority	$19,905
Low priority	$ 3,110
Total	**$59,461**

Conservation tillage, windbreaks, and cover crops are the recommended BMPs for preserving soil erosion from wind transport and overland flow. Conservation tillage is a method of leaving crop residue on the field over the winter until time of planting. Conservation tillage practices also include no till farming, when seeds are drilled between the previous year's rows and the field is not tilled. Costs are lower to farmers who use this method since less fuel is used in farm operations. In worst case scenarios, additional pesticides may be necessary to prevent fungus and disease from insects that over-winter in crop residue. In this case, a farmer could expect an increase of $10 per acre for implementing no-till practices.

Cover crops are recommended for muck soils operations. Since these soils have such low organic strength, they are very susceptible to wind erosion. Research completed by Mr. Richard Hardwood of the Michigan State University Agriculture Engineering Department has shown that incorporating cover crops into corn and soy rotations can add $100 to $150 per acre in production increases and input savings. Cover crops decrease reliance on fertilizers and herbicides, increase habitat for beneficial insects and birds, and add additional revenue if the farmer decides to harvest the cover crop and sell it as forage. A no risk cover crop of clover has a cost of $12 per acre, which can be cost-shared through the Natural Resource Conservation Service. Using a cover crop of rye or winter wheat is a more risky endeavor, but if the crop is successful, it can be harvested and sold resulting in a net gain.

Windbreaks are suggested to slow wind velocity and to promote the settling out of soil particles. Trees planted two or three rows thick with a row of shrubs beneath them provide an excellent windbreak. Windbreak establishment can be very expensive, however the Stewardship Incentive Program and the Conservation Reserve Program (CRP) may provide up to a 75% cost-share from approved Forestry Management Plans. Typical cost for clearing land, planting, and maintenance have been reported at $225/acre by the USDA Farm Service Agency. A 40-acre field would need about 3.6 acres of windbreak to provide adequate protection. Addition benefits to windbreaks are significant decreases in pesticide drift and airborne sediments, slight increases in irrigation efficiency, and improvement in wildlife corridor structure.

Buffers or filter strips are also recommended in all agricultural fields identified in the critical areas. Filter strips are simply strips of grass, trees, or shrubs that slow the flow of water and cause contaminants like pesticides, nutrients, and sediments to collect in vegetation. Filter strips can quickly be established in the interim time before windbreaks or other managerial BMPs can be implemented. Filter strips are eligible for many state and federal programs that pay farmers a rent for lands being used as buffers. Typical rental rates are 20% higher than the local average land rental rates, however, if Section 319 or CRP funds are available, lease rates can be considerably higher to provide a greater incentive to farmers and landowners. Currently, the average rental rate for southwest Michigan is $58 per acre.

In addition to vegetative BMPs, the TMDL agriculture stakeholders committee has vehemently requested additional programs to support nutrient management. Phosphorus runoff from row and muck crops is severely impairing the Watershed, and the fastest method to deal with these inputs would be to eliminate or significantly reduce phosphorus inputs into the Watershed. Many plans and programs are available to farmers who wish to adopt a nutrient management policy, yet no funds are available for these programs. Promotion and intensification of the Michigan State University Extension soil testing program is needed to help offset the risk to reducing fertilizer applications.

5.3.2 STREAMBANK EROSION

Streambank erosion is another large contributor to sediment in the Watershed. When a stream or county drain is channelized, streambank erosion often occurs as the stream attempts to return to its original path. This streambank erosion is the cause of impairments to agriculture drainage and irrigation, fish habitat, and macroinvertebrate communities. In addition to sedimentation, stream erosion could also be responsible for a portion of the phosphorus (that is bound to soil particles) loading to the Kalamazoo River Watershed.

Many techniques have been demonstrated to reduce streambank erosion. Hard structures, such as riprap, can protect the toe of a streambank. Tree revetments, fascines, and live plantings are softer methods that are generally preferred since they absorb energy from the stream rather than reflect it downstream as riprap often does. Bioengineering, an integrated approach based in physics, chemistry, and engineering principles that uses biological methods of control, can be very effective in establishing long term and adaptable solutions to erosive problems. Bioengineered systems are designed using non-destructive techniques that often have the ability to adapt to changing conditions over time. Materials can usually be found locally or even onsite, reducing cost and incorporating native resources. In many cases riprap and tree revetments provide a comparable, and in some cases, better habitat for fish and invertebrates than natural streambanks. Sites, potential BMPs, and costs are given in Table 5.2. Each site should be examined and the principles described in this section should be applied.

Table 5.2 - Streambank Erosion Sites BMP Cost

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
407GUN0103		N			Both	>100'	>6'	Washout	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	200' of unstable banks on both sides, some road shoulder erosion, light vegetation
40GUN0201					Right bank	>100'	>6'	Washout	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
40GUN1801C	107th Street Bridge	Y			Left bank	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
1059GUN1101		N	AG	AG	Both	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Bacterial sheet and lots of aquatic, plants, dark organic soil
1061ORA0901	West side next to Mullenhurst golf	N	Golf	Idle	Both	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Might be crossing from agricultural. land, golf course eroded drain
1071MAR1410	u/s from storage tank	<1'	AG	AG	Left bank	>100'	>6'	Mostly bare bank	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Very long stretch of eroded bank, short area OK, than another long stretch eroded
1059MAR2514		<1'	AG	AG	Right bank	>100'	>6'	Mostly BARE bank	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
571MAR2401	300 ft east of 2nd Street many point along bank		AG	Road	Right bank	>100'	>6'	Mostly bare bank	Top of bank	2,000	Bioengineering	$4/foot - bioeng.	$800	H	
408MAR3601B	100 ft. u/s from mouth 408	3'-10'	AG	AG	Right bank	26'-100'	3'-6'	Washout	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40MAR2308			Utility	Utility	Left bank	26'-100'	>6'	Washout	Entire bank	1,000	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$7,953	H	Erosion under utility pole
RDWAY3401	Northwest corner 124th and 5th	<1'	AG	Road	Both	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40MAR1301C	120th Avenue crossing		AG		Right bank	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40GUN105					Left bank	26'-100'	>6'	Mostly bare bank	Entire bank	1,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40MAR2307		Y	AG	Woodland	Left bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Erosion at irrigation point, old diesel-smelling fire engine used for pumping
40MAR2606					Left bank	10'-25'	>6'	Washout	Entire bank	250	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$2,028	H	Erosion threatens utility pole
403GUN1602B			Road	Road	Right bank	>100'	3'-6'	Washout		1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
40ORA0601C	Patterson road crossing	3'-10'			Both	<10'		Washout	Entire bank		Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap		H	
1060ORA1802	1st trib u/s from Patterson		AG	AG	Both		3'-6'	Washout	Entire bank		Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap		H	
40GUN0208					Right bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	

Table 5.2 - Streambank Erosion Sites BMP Cost

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
40GUN0204					Right bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR2303					Left bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1071MAR1002	By ag/woods		AG	Woodland	Both	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1058GUN1102		N	AG	AG	Both	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1071MAR1413	500' W of farm crossing, farm access road to N	1'-3'	AG	AG	Left bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR3606					Left bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
5721MAR3602	off farm access road	<1'	AG	AG	Right bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Problem persists intermittently 500 ft
1058GUN1101	At meander	N	AG	AG	Right bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR2607			AG	Road	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Erosion at top of road grade
1071MAR1408	Near end of cornfield	<1'	AG	AG	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Eroded and slumping, might be recovering but animal path still eroding it
1060ORA1801	East side Patterson road and 120th		AG	RES	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	No buffer nutrients from field wash off. another 30' u/s pic #34
40GUN0207		3'-10'			Left bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	LP gas and diesel irrigation upstream
1071MAR1504	500 ft u/s from 4th		AG	AG	Both	10'-25'	>6'	Mostly bare bank	Entire bank	250	Remove obstruction Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap and $325/hour	$2,625	H	Tree fell in (L) pushing water toward bank (R), pic avail
1058MAR2501	farm drain off 1059 going S, 30 ft. from 114th Avenue		Road	Road	Right bank	10'-25'	>6'	Some bare bank	Toe	250	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$2,028	H	Culvert comes in, making a right turn, erodes far bank which electric pole is on and falling in
1071MAR1405	d/s from fallen tree	<1'	AG	AG	Left bank	<10'	3'-6'	Mostly bare bank	Entire bank	60	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$790	H	lots of big limbs piled, washing out bank
1060ORA1804		>10'	AG	AG	Right bank	<10'	>6'	Mostly bare bank	Entire bank	100	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$790	H	
1071MAR1503	400ft u/s 4th	<1'	AG	AG	Right bank	<10'	>6'	Mostly bare bank	Entire bank	100	Remove obstruction Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap and $325/hour	$1,115	H	Small tree fallen, creates gouging, picture No. 4
1076MAR2301	Just upstream from trailer	<1'	Road	AG	Left bank	<10'	3'-6'	Some bare bank	Entire bank	60	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$843	H	Utility box falling in
571MAR2402	500 ft e of 2nd		AG	Road	Left bank	>100'	>6'	Some bare/mostly	Top of bank	2,000	Bioengineering	$4/foot	$800	M	No buff, washes off field, conventional tillage

Table 5.2 - Streambank Erosion Sites BMP Cost

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
								bare							
40GUN0103B	200' upstream in ditch adj. CORN				Right bank	>100'	3'-6'	Some bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	M	
407GUN0101	Along roadside 2nd street. across from farmhouse	N	AG	Road	Both	>100'	>6'	Some Bare bank	High water	2,000	Bioengineering	$4/foot	$800	M	
40MAR2302B			AG	Road	Left bank	>100'	>6'	Some Bare BANK	Entire bank	2,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$16,240	M	Bank slumping into river, corn up to top of bank
1071MAR1415	At end of woods	>10'	AG	Woodland	Left bank	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	M	Looks like it has been slowly eroding for years, might just erode at heaviest rains
1060ORA1803			AG	AG	Both	26'-100'	>6'	Some bare/mostly bare	Entire bank	1,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$8,813	M	Slumping bank with concrete
1071MAR1407	Next to field, near large willows	<1'	AG	AG	Right bank	26'-100'	>6'	Some bare bank	Toe	1,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$8,120	M	Stream is meandering, exposing plastic conduit, which comes from top of bank
575MAR2601	At west side of 1st field on right	3'-10'	AG	AG	Left bank	10'-25'	>6'	Mostly bare bank	High water	250	Bioengineering	$4/foot	$100	M	Lots of shrubs and woody debris down center of drain
40GUN0104B	Drainage ditch intersection				Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
40MAR2603B			AG	Road	Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
1071MAR1409	Rusted tank shell on S. side of drain	<1'	AG	AG	Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
40GUN1752C					Left bank	<10'	>6'	Washout	Top of bank	100	Bioengineering	$4/foot	$40	M	
59MAR1003		1'-3'	AG	AG	Left bank	<10'	3'-6'	Mostly bare bank	Top of bank	60	Bioengineering	$4/foot	$40	M	
407GUN0102	100 yards south of bridge	Y	AG	Road	Left bank	<10'	>6'	Mostly bare bank	High water	100	Bioengineering	$4/foot	$40	M	
1071MAR1404	Across from barn	<1'	AG	AG	Left bank	<10'	>6'	Some bare bank	Toe	100	riprap	$75/$yd^2$	$750	M	Looks like they tried to put a piece of plastic in to hold it, but plastic washing out
572MAR3601	Along farm road	N	AG	Road	Left bank	<10'	3'-6'	Some bare bank	Top of bank	60	Bioengineering	$4/foot	$40	L	Lots of aquatic. plants, another 100 ft. u/s
40GUN1001C	110th Ave. Bridge	Y			Left bank	<10'	>6'	Some bare bank	Top of bank	100	Bioengineering	$4/foot	$40	L	Metal retaining wall at ditch enters from east and irrigation. downstream

Cooperation with the county drain commissioners on work proposed for county drains is necessary. The remedies must not interfere with the regular maintenance and cleaning of the drains. Generally, most vegetative remedies, such as grasses and shrubs, are acceptable, but trees may interfere with drain maintenance and roots too close to the edge may actually exacerbate erosion. Mixtures of rhizomatous woody shrubs and herbaceous plants are ideal unless the goal is to reduce water temperature. Trees should be maintained on the south and east sides of drains, so the canopy shades the water, which keeps it cool, preserves habitat, and reduces algal growth. Responsibilities for maintenance of the remedy is a concern as well. If additional plantings are recommended on a site that requires drain maintenance, the additional costs would have to be passed on to the landowners. The landowners should be allowed to decide if they are willing to absorb any costs associated with increased maintenance in favor of having trees on or near the banks in the drain right-of-way.

Brush bundles and tree revetments incorporate the use of plant material to protect the bank in slow and moderate flows, as well as reestablishing bank vegetation, which grows from the sediment that is deposited in the crevasses. These remedies cost about $12 per yard since it is usually done with vegetation found onsite and can be done with little equipment and labor. Live staking is done in late autumn or early spring when the trees are dormant. These stakes will grow into short shrubby trees with complex root systems as the growing season progresses. Tree revetments can be made of old Christmas trees that have been anchored parallel to flow along the toe of the streambank. Once installed they direct flow away from the bank and catch sediment, which will deposit and accumulate behind the revetment and stabilize the bank. Many sites could benefit from this vegetative remedy to divert the flow rather than provide extensive bank protection. Previous projects implementing this river restoration technique have bid average costs of $220 per 100 feet of streambank.

Costs for hard methods of streambank stabilization are difficult to estimate since it is very site specific and largely depends on the cost of site preparation. Riprap is the most common method of toe stabilization, but it should be used sparingly and with much consideration. Riprap is excellent for diverting flow and protecting banks, however, stream energy can be diverted downstream and only heighten erosion at another site downstream. A detailed engineering study is essential for any projects the will be installing riprap. Estimates for riprap for streambank erosion using D50 stone is $75/square foot, which includes the delivery to the site. Riprap tends to be less cost effective and does not meet as many of the goals outlined in this plan as the bioengineering techniques. Therefore, it should only be used where flow velocities and direction will not sustain bioengineering.

In a number of cases in the Watershed, the stream is eroding the streambank as the watercourse is trying to reestablish meanders. This type of erosion is a natural occurrence, nevertheless, in a channelized river system, it will cause a great amount of sediment if not remedied. The BMP for eroding stream bends is to

pull the bank back mechanically. In this way, the bank is physically removed before the stream carries it as sediment during the next storm event. Typical costs for this BMP can be up to $6 per cubic yard of bank removed plus the cost of bioengineering once the bank has been sloped.

5.3.3 RILL AND GULLY EROSION

Rill and gully erosion is generally found in agricultural areas where fields are tilled by conventional methods and plowed next to the streambank where no filter strips exist. Rill and gully erosion is responsible for impairments to fish habitat, irrigation, drainage, and aquatic habitats for invertebrates and plants. Sediment carried in rill and gully erosion is also extremely high in phosphorus and other contaminants associated with agricultural soil uses.

Typical BMPs include drop structures, weirs, and stone spillways. Sites, recommended BMPs, and costs are listed in Table 5.3. All structures need adequate preparation to ensure the water flows where intended. Natural Resource Conservation Service (NRCS) has installed many of these structures over the years. Average costs per site are $1,500, assuming reasonable accessibility and using 4 inches to 12 inches of crushed limestone of various sizes. Geotextile vegetated chutes are designed for smaller sites with less runoff.

Table 5.3 - Rill and Gully Erosion

Site ID	Description	Land Use	Buffer	Height	Width	Depth	Length	Volume	Proposed Improvements	Estimated Cost/Site*	Estimated Total Cost**	Priority	Comments
1071MAR1501	100 yds. u/s from 4th	AG		3'-6'	2	8	10	160	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$211	H	Gully off field - conventional corn, picture Nos. 1 and 2.
1060ORA1806	Just up stream from 1st	AG		>6'	4	2	12	96	Grassed waterway	$2245/acre	$4,490	H	Across from each other ground disturbed, cut trees off bank, moved soil on edge u/s 300 ft.
1059MAR2511	Toward curve in 1059	AG	<1'	>6'	3	2	15	90	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$475	H	Log fell 20' further d/s backing up water, left bank slumping, gully off corn field red. Flow
59MAR1002	East of woods on west side of stream, field to S&N	AG	3'-10'	3'-6'	6	4	15	360	Berm and Tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,900	H	Gully on L w/trib. draining from field on right
1059MAR2503	At start of corn on right bank	AG	3'-10'	>6'	2	3	20	120	Branch packing	$25/foot	$500	H	Gully at corner of field, goes over so that it's mostly buried
1059MAR2506	Halfway through field on left bank	AG	>10'	>6'	5	5	20	500	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$1,056	H	Off 30-40 ac field w/ little slope, plus streambank erosion 100 ft. u/s same bank
1059MAR2513	U/S of curve	RES		3'-6'	6	3	20	360	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$2,033	H	
572MAR3604	Near end of 1st field	AG	<1'	<3'	3	1	25	75	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,833	H	Gully off field, but drops sharply at bank, erodes 4' d/s
1059MAR2505	2nd field on left 100' in	AG	>10'	>6'	10	5	30	1500	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$2,833	H	Large gully off 30-40 acre soy bean field
RDGUN0101A		Wood		3-6'	8	3	100	2400	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$5,056	H	
1071MAR1402	By driveway, behind metal building	AG	N	>6'	2	2	7	28	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$148	M	Attempts were made to fix erosion with cement blocks
572MAR3605	Almost to end of field	AG	<1'	>6'	3	2	8	48	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,607	M	Drains from field w/ sharp drop off
1059MAR2501	500ft U/S from 2nd	AG	<1'	>6'	3	2	8	48	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$253	M	
1071MAR1505	550 U/S from 4th	AG		3'-6'	2	2	10	40	Grassed waterway	$2,245/acre	$4,490	M	Gully forming off field
1071MAR1001	South side of section 10 at exit of woods and another 100' U/S	AG	<1'	3'-6'	2	1	12	24	Branch packing	$25/foot	$300	M	Gully formed from runoff from field
575MAR0201	100 ft. S of blue house after turn in drain	AG	1'-3'	>6'	1.5	2	15	45	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,600	M	Field slopes toward point
572MAR3602	100ft. u/s from farm rd.	AG	1'-3'	<3'	2	1	25	50	Grassed waterway	$2,245/acre	$4,490	M	Goes into field 20 ft., rich organic soil, LOTS aq. plants
105MAR2509A	150FT U/S from 03	AG	>10'	>6'	2	3	25	150	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,722	M	
5721MAR3603	Off farm access rd. 100 ft. south of 114	AG	<1'	3'-6'	1	1	40	40	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,678	M	Gully runs along farm road then turns into drain
1059GUN1104		AG	N	3'-6'	3	2	12	72	Grassed waterway	$2,245/acre	$4,490	L	Picture available

Table 5.3 - Rill and Gully Erosion

Site ID	Description	Land Use	Buffer	Height	Width	Depth	Length	Volume	Proposed Improvements	Estimated Cost/Site*	Estimated Total Cost**	Priority	Comments
5721MAR3601	Just off farm access road	AG	<1'	3'-6'	2	2	2	8	Grassed waterway	$2,245/acre	$4,490	L	Along access road by drain
1058GUN1103		AG	N	3'-6'	2	1	8	16	Berm and tube with vegetated geogrid	$1500/ berm and $20/yd^2 geogrid	$1,571	L	Picture available
1059MAR2515		AG	<1'	>6'	1	1	12	12	Grassed waterway	$2,245/acre	$4,490	L	
*Grassed waterway average 2 acres **Cost are based on 1st year implementation. Future years are $58/year lease on conservation lands										High Priority Medium Priority Low Priority Total	$20,387 $16,288 $15,041 **$51,716**		

5.3.4 TILE OUTLETS

Tile outlets should be upsized when constructed to plan for future capacity needs. Rodent guards should always be included. The outlet should be lined with geotextile and stone should be placed in the trench. Many sites in the Watershed are eroding where storm sewer outlets are eroding back into the streambanks and causing gullies. Typical causes for these erosive forces are undersized tiles or outlets so high that splash energy is creating splash pools and eddy currents. Catch basins and old tile lines could be adding sediment to the stream system. Stabilizing a tile outlet has an average cost of $75 per square foot of riprap and $12 per yard of bioengineering. Sites, recommendations, and cost totals are shown in Table 5.4.

5.3.5 ROAD/STREAM CROSSINGS

Road crossings of the Gun River and its tributaries are a serious concern in the Watershed. In some areas, culverts are undersized or blocked causing water to back up and flood upstream areas. When this happens, erosion occurs around the road crossing. Undersized or blocked culverts can be replaced with box culverts or bridges, however, in almost all cases the replacement of culverts and bridges is not covered by grant programs. The most cost effective BMP for undersized culverts may be to stabilize the hydrology in the Watershed and to prevent sediment from blocking culverts. Once other impairments have been addressed, another detailed road/stream crossing inventory would be needed to evaluate the condition of these sites. Additional concerns about navigation may also dictate the replacement of undersized culverts that are not tall enough to allow passage of boaters. Site specific remedies are shown in Table 5.5.

5.3.6 TRASH AND DEBRIS

Trash and debris not only create unsightly conditions, they also divert stream flow into the banks causing erosion and drainage impairments. Trash hidden under murky waters also makes it difficult or dangerous for recreational stream users. Removing log jams and heavy items from the stream bed can be a difficult and expensive process since it must be done by hand. The removal of log jams should not be attempted by volunteers since it gives rise to liability issues for the sponsoring agency. Funding for obstruction removal can be found with 319 implementation grants, Adopt-A-Stream programs, and the Environmental Protection Agency (EPA) 5-Star grant. Smaller projects, like trash clean-ups, can be tackled by volunteer groups. Since most of the water courses in the Watershed are designated county drains, the drain commissioner would be largely responsible for the removal of obstructions. A schedule of obstruction removal, estimated costs, and responsible agencies is in Table 5.6.

Table 5.4 - Tile Outlet BMP Costs

Site ID	Description	Buffer Width	Outlet Erosion	Outlet Diameter	Outlet Height	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost*	Estimated Total Cost	Priority	Comments
40MAR3603	pipe outlet from building (Hooper)		Y	6"	0"-6"	10	Check Inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$1,350	H	Possible floor drain from pole barn
572MAR3603	100 yds. u/s from farm rd.	<1'	Y	8"	0"-6"	10	Check Inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$1,350	H	Outlet covered by aq. plants; inside- 3" tan colored algae, muck w/white film on top & dk. brown
59MAR0305	500 ft d/s from 124th	3'-10'	Y	9"	>36"	20	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,250	H	Digging out stream bottom
1059MAR2502	End of corn field u/s from 2nd	3'-10'	Y	9"	>36"	40	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$3,900	H	End of piece about to fall off bank
59WAY3401	Across from farm house	N	Y	6"	12"-36"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	H	Slight erosion, no buffer on fields - lots of aquatic plants - eutrophic
105MAR2509B	150 FT u/s from 03	>10'	N	8"	0"-6"	N/A	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$1,530	H	Two rusting through Tile outlet, one flowing - erosion, one not - smells musty & erosion
572MAR3606	Second field 1/2 way	<1'	Y	12"	12"-36"	15	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$2,205	H	Tile outlet rusted through, hanging bent into stream, water comes out hole, eroding bank
408MAR3601A	100 ft. u/s from mouth 408	3'-10'	Y		0"-6"	15	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$2,205	H	Tile outlet rusted out, water comes out bottom, below is bac. sheet, iron bacteria, and aq. plants
1071MAR1406	U/S from fallen tree, just up from barn	<1'	Y	9"	12"-36"	20	Check inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$2,250	M	not presently flowing, but 1/2 full of muck
1071MAR1403	Next to barn	N	N	12"	0"-6"	N/A	Extend outlet	$30/foot - repair and $150/hour labor	$780	M	Tile outlet doesn't extend over stream, depositing lots of dark sediment on bank slope
1071MAR1401	Just upstream from 2nd St. bridge	N	Y	18"	12"-36"	20	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,400	M	
40GUN0207		3'-10'	Y	4"	12"-36"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	M	LP gas and diesel irrigation upstream
1059MAR2517		>10'	Y	12"	12"-36"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,650	M	
40GUN0203			Y	4-6"	12"-36"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,650	M	Three tile outlets and irrigation point
407GUN0104			Y	6"	6"-12"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	M	
40MAR3501	200' upstream from 2nd Street bridge north of Hooper		Y		>36"	N/A	Riprap	$75/yd2	$750	M	Drop inlet opening stable, but field eroding at inlet
40GUN0209			N	10"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0210B	bridge crossing 2nd Street	>10'	N	8"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0102			N	8"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0101			N		>36"	N/A	Maintain	$60/yr	$60	L	
40MAR3602A			N		12"-36"	N/A	Maintain	$60/yr	$60	L	Tile outlet appears inactive
40MAR2602			N	12-14"	12"-36"	N/A	Maintain	$60/yr	$60	L	
407GUN0105B		1'-3'	N	>12"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR2304			N	8"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR3607			N	12"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR3503B			N	12-14"	12"-36"	N/A	Maintain	$60/yr	$60	L	
1071MAR1003	At curve in cornfield		N	9"	6"-12"	N/A	Maintain	$60/yr	$60	L	
403GUN1603	Midpoint along ditch at tile outlet	3'-10'	N		6"-12"	N/A	Maintain	$60/yr	$60	L	
40MAR3502B			N		0"-6"	N/A	Maintain	$60/yr	$60	L	Drop inlet or side inlet pipe for surface water, no flow
40MAR1201C	122nd Street crossing	3'-10'	Y	8"	0"-6"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,350	L	
40GUN0209			Y	6"	0"-6"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,350	L	Two tile outlets side by side
1071MAR1502	350 ft from 4th u/s		N	8"	12"-36"	N/A	Maintain	$60/yr	$60	L	Erosion on bank around 2 to 6 outlets
*Labor cost of $150 hour are added to account for any use of heavy equipment in addition to materials								Medium Priority	$13,530		

Table 5.5 - Road Stream Crossing BMP Costs

Site ID	Description	Erosion Location*	Condition	Buffer	Extent of Erosion	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
407GUN0106		SB/EB/SD	Poor		SEVERE	Replace Culvert	$382/foot	$9,168	H	
406GUN1102		CO	Fair	1'-3'	SEVERE	Riprap	$75/yard^2	$900	H	
575MAR0202	124th Street west of 4th	CO	Poor	>10'	SEVERE	Replace Culvert	$382/foot	$11,460	H	Concrete casing fell off, culver high, huge pool underneath
59MAR1101	120th Avenue	EB	Poor	1'-3'	SEVERE	Repair Culvert/Bridge	$1125/foot	$28,125	H	
402GUN2101	Crossing 106th	ALL	Good	N	SEVERE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	H	
40ORA0601A	Patterson Road crossing	SB/CO/SD	Good	3'-10'	SEVERE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	H	
573MAR2601	Crossing 114th and 4th	SB/EB	Good	<1'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
1060ORA1701	9 Mile Road crossing	EB	Fair	>10' RT. ONLY	SEVERE	Bioengineering	$4/foot - $75/yd2 - riprap	$792	H	
1059MAR2501B	At county line crosses Boysen Road north of 114th	EB	Fair	3'-10'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
1060ORA1807	Crossing near farmhouse and corn storage	SB	Fair	<1'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
575WAY3501	By dairy on 4th Street	EB	Poor	N	MODERATE	Replace Culvert	$382/foot	$9,550	H	
571ORA1901	Boysen Road in woods	EB	Fair	>10'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
40MAR1301A	120th Avenue crossing	SB	Poor		MODERATE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	M	
573MAR2701	5th Street 1/3 mi. north of 114th	EB	Fair	<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
577MAR0101	At end 577 bend	SB		<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
59MAR0304A	Livestock crossing	RB	Poor	N	MODERATE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	M	
4061GUN1101	1/4 mi east from section line 10/11	CO	Good	3'-10'	MODERATE	Riprap	$75/yd^2	$600	M	
1059MAR2516	2nd cross	EB	Fair	<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
407GUN0105A	bridge crossing 2nd Street		Fair	1'-3'	MINOR	Bioengineering	$4/foot - tree revetment	$192	M	
570MAR2604	Crossing westridge on north cornfield, south of blue and tan house	SB	Poor	1'-3'	MINOR	Replace Culvert	$382/foot	$9,168	M	Vehicle crossing, gravel in stream bed
1057GUN1401	West of 3rd on Pierce Road / 106th Avenue		Poor		NONE	Bioengineering	$4/foot - tree revetment	$192	M	
1060ORA1805			Poor		NONE	Replace Culvert	$382/foot	$9,168	M	Undersized culvert 3/4 full not right after storm. pic #39.
40GUN1101			Good		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	Upstream side blocked by debris, downstream open
403GUN1604A	600' upstream from Gun on 7th St.		Good	>10'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40GUN1801A	107th St. Bridge		Good	Y	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40MAR2601	Crossing at 114th Ave. and 2nd St.		Good		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40GUN1701	10th st bridge	NONE	Good		MINOR	Bioengineering	$4/foot - tree revetment and $125/hr	$96	L	
40GUN1801	Bridge at Gun River Conservation Club, 11th St.	NONE	Good	>10'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40GUN1001A	110th Ave. Bridge		Good	Y	MINOR	Bioengineering	$4/foot - tree revetment and $125/hr	$96	L	Metal retaining wall at br. ditch enters from east and irrig. downstream
40MAR2301	116th Ave. bridge at 2nd St.	CI	Good		MINOR	Riprap	$75/yd^2	$450	L	
570MAR2605	crossing at big tan house	SB	Good	1'-3'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	Single culvert, lg rocks on both banks E of crossing, pics
40GUN1702B		SB	Fair		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40MAR2604	Trib. crossing on 2nd St.		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	Rust colored water coming from culverts
40MAR1401	118th St. crossing		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40MAR1402A	2nd st crossing n of 118th		Fair	3'-10'	NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	1920s bridge
40MAR1201A	122nd st crossing		Good	3'-10'	NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	Triple culvert
40MAR3601			Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40OST2401	n farmer st / 106th street bridge		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40ORA0602A	gun river wier		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
403GUN1602A			Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40GUN1703	9th st bridge	None	Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40MAR3608A	2nd St. bridge N. of Hooper		Fair		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	

Long-term educational efforts about the impacts of litter and debris in the streams will increase the stewardship of the Watershed and encourage residents to recognize the value of their water resources. A volunteer clean-up grant should be sought to involve local residents in stewardship activities. Community involvement not only promotes respect for and interest in the Watershed, but also provides an enthusiastic workforce. Local match for the grant can include the use of canoes, dump trucks, landfill tipping fees (especially if tires are included) and communication radios for safety. It is important to inform volunteers of safety concerns and have release of liability forms for them to sign.

5.3.7 OTHER SITES AND CONSTRUCTION SITES

Other pollutants were found in the Watershed that did not fit into the established categories and were collected under the "other" category. Most of these sites identified excessive algal growth or water quality concerns like odor, color, and foaminess. These would have to be evaluated on a site-by-site basis to determine the costs for removal or finding the source of the excessive nutrients entering the streams. A list of sites and basic recommendations are listed in Table 5.7.

One construction site was identified during the Watershed inventory as contributing NPS pollution to the Watershed (Table 5.8). Additional sites will be added to the list if found.

Inventory sites on Gun Lake require a different approach for BMPs. As described previously, a buffer around Gun Lake of 200 feet is incorporated into the Watershed's critical areas. The main impairments to Gun Lake's desired uses are pathogens, nutrients, and invasive, and exotic species. The best way to address these concerns is not through structural or vegetative BMPs, but through information and education of riparian populations.

Previous studies done by the Michigan Department of Natural Resources (MDNR) and a private water quality consultant have identified a number of practices for riparian landowners that will enhance the Gun Lake recreation potential.

- Burn leaves, brush, and garbage away from the lake.
- Compost leaves or rake them away from the lake and bag for removal.
- Use lake-safe fertilizers on lawns, if necessary, with no phosphorus and slow release nitrogen.
- Use lake water to water lawn and gardens.
- Preserve natural vegetation along shoreline.
- Use phosphate free detergents in and around the house.
- Remove aquatic weeds by hand, not herbicides.
- Protect wetlands adjacent to the lake.

Table 5.6 - Trash and Debris BMP Costs

Site ID	Description	BUFFER	Land Use Left	Land Use Right	Amount	Proposed Improvements	Estimated Cost/Site	Estimated Total Cost	Priority	COMMENTS
1071MAR1508	Across from white house		Woodland	Woodland	Extensive	Obstruction removal - dam	$150/hr	$1,200	H	Owners built dam with rocks and concrete, probably w/o permit, 15' wide, 3' tall
59MAR0302	W of barn/north of 595		AG	AG	Extensive	Obstruction removal - ext.	$4/ft	$400	H	Heavy overgrowth and fallen trees for over 100'
570MAR2606	West end of section 26	>10'	AG	AG	Extensive	Obstruction removal - ext.	$4/ft	$1,600	H	Numerous trees and branches, approx. 400'
574ORA0701	West of intersection Wildwood and Rook		RES	Road	Extensive	Obstruction removal - ext., volunteer clean-up	$4/ft	$460	H	Lumber, tree, u/s fridge, TV, and deer ribcage, clogged driveway culvert
570MAR2701	Just upstream from 26/27 section line	>10'	Idle	AG	Moderate	Obstruction removal - ext., volunteer clean-up	$4/ft	$460	H	Lots of logs down, brushy shrubs in stream, some barbed wire left bank
59MAR1004	Across from 592, 50' north of 592 and further u/s	1'-3'	Woodland	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Branches/trees in stream causing erosion
1060ORA1809	Near end of woods	>10'	Woodland	Woodland	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Bunch of fallen trees - diverting water into bank
570MAR2603	350 upstream of power lines	1'-3'	AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Fallen trees created sandbar
1059MAR2507	Just upstream from AG crossing				Moderate	Obstruction removal - mod.	$4/ft	$200	H	Lots of trees down, just u/s from crossing
571MAR2401	300 feet east of 2nd Street		AG	Road	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Road runoff eroding bank, little buffer, opposite bank no buffer, trees dumped on bank
1059MAR2509	At town line drain - Fallen tree		AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Tree down, branches caught causing drain to snake around, erosion on both banks
1071MAR1414	In woods	>10'	Woodland	Woodland	Slight	Obstruction removal - slight	$4/ft	$40	H	Logs down causing stream to divert
40GUN1702A					Slight	Volunteer clean-up	$60/day	$60	H	Car battery/toilet
59WAY3402	126th Street at dip in road	>10'	Woodland	Woodland	Extensive	Obstruction removal - ext.	$4/ft	$400	M	Lots of fallen trees
1071MAR1507	By white house		RES	Woodland	Extensive	Obstruction removal - ext.	$4/ft	$400	M	Tiles on large bank falling in
40GUN0104A	Drainage ditch intersection				Moderate	Obstruction removal - mod.	$4/ft	$200	M	Log jam, portage point
59MAR1001	Halfway between 2nd and 121st in fields, plus further up	<1'	AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	M	Lots of fallen trees
1057GUN1501	Just off Marsh Road	N	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	M	15 ft. metal pipe, rusted through & laying across stream, little erosion
1059MAR2512	Just u/s from large bend	<1'	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	M	Huge tree lying across bank, threatens to fall in
1071MAR1506	West side of cornfield by woods		AG	Woodland	Slight	Obstruction removal - slight	$4/ft	$40	M	Log jam
1060ORA1808	Border ag/woods		AG	AG	Slight	Obstruction removal - slight, volunteer clean-up	$4/ft - obstruction $60/day - volunteers	$100	M	Barbed wire/electric fence across stream, pallets in water
1071MAR1411	By 3rd field going West	<1'	AG	AG	Slight	Obstruction removal - slight, volunteer clean-up	$4/ft - obstruction $60/day - volunteers	$100	M	Palette, Styrofoam, fallen tree
40MAR3602B		Y			Moderate	Volunteer clean-up 2 days	$60/day	$120	M	Barrel, steel debris (fencing), etc.
40MAR2305					Moderate	Volunteer clean-up 2 days	$60/day	$120	M	Farm debris
40MAR3605	Tributary intersection	Y	Woodland	Woodland	Slight	Volunteer clean-up	$60/day	$60	M	Two tires, bucket
1059MAR2501A	At county line crosses Boysen Road north of 114th	3'-10'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	M	Air conditioner
40MAR3503A					Slight	Volunteer clean-up	$60/day	$60	M	Metal barrel and wooden stairs
5702MAR2101	Across and u/s from new houses	N	AG	RES	Slight	Volunteer clean-up	$60/day	$60	M	Some concrete in river, lots of trash 20 ft. from bank, tires, car, appliances
1060ORA1810	About 100 yds u/s of Saddler Road	>10'	Woodland	Woodland	Slight	Volunteer clean-up	$60/day	$60	M	Some trash - tires, siding, etc. 2 pieces diverting stream
570MAR2602	At 1st town going u/s from 2nd street	3'-10'	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	L	Lots of shrubs/small trees and threw in at curve
1059GUN1102		N	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Lots of debris - bricks on bank & irrigation pipe
570MAR2601	At north side of 1st field on right bank	3'-10'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Lots of shrubs and woody debris down culvert
1071MAR1412	15' east of farm crossing	<1'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Rocks/manmade deposits
							High Priority Medium Priority Low Priority Total	$5,420 $2,060 $220 **$7,700**		

Table 5.7 - Other Site BMP Costs

Site ID	Description	Color	Water Odor	Buffer	Land Use Left Site	Land Use Right Side	Proposed Improvements	Estimated Unit Cost*	Estimated Site Cost	Priority	Comments
1060ORA1802	1st Trib. U/S from Patterson	No water	None		AG	AG	Filter strip	$190/acre and $58/year lease	$628	H	200 ft, no buffer, sandy soils
40GUN0205		Cloudy	None	N	AG	AG	Filter strip	$190/acre and $58/year lease	$628	H	Grazing right up to bank, eutrophic
GL03		Clear	None	N			Turf management BMPs	$175/plot	$1,750	H	Lawns mowed to edge, autumn leaves on bank & in lake
59MAR0303	East of long barns, 1,000' d/s from 124th	Clear	None	N	Wetland	RES	Wetland restoration	$2,530/acre restoration	$1,265	H	Owners turned wetland into wet lawn
40GUN1704	9th Street bridge	Clear	None	N	Golf	IDLE	Filter strip crossing Improvement	$78/acre $1,200/crossing	$1,770	H	Possible agriculture crossing, golf course, eroded drain, picture 19
GL04		Cloudy	Musty		Road	RES	Check for septic failure, turf management BMPs, roadside filter strips	$78-$2,530/acre	$1,910	H	Unsure of source, but water is cloudy & pungent musty odor
4031GUN1601	On 7th, road ditch to side street, all along roadside						Solar or Electric Irrigation	$3,800/pump and controls	$3,800	M	Diesel irrigation point
GL02		Clear	None	N			Filter strip	$190/acre and $58/year lease	$628	M	Foamy water, picture available
1067YAN1701	Cobb Lake Road crossing						Maintain site	$60/year	$60	L	Irrigation point, electric on pad
1061ORA0901	West side next to Mullenhurst golf	Clear	None	N			Monitor	$60/year	$60	L	Zebra mussels, picture available
*Cost are based on 1st year implementation. Future years are $58/year lease on conservation lands. *Estimates assume 3 acres for filter strips and half acre residential plots								High Priority Medium Priority Low Priority **Total**	$7,951 $4,428 $120 **$12,499**		

Table 5.8 - Construction BMP Costs

Site ID	Description	County	Township	Section	QTR 1	QTR 2	Color	Buffer	CONSTRUCTION TYPE	Erosion Control Measures	Sediment Control Measures	Extent	Recommended BMP	Estimated Cost/Unit	Estimated Costs	Comments
GLORA0901	New development	Barry	Orangeville	9	NW	NW	Clear	N	RES	Not Installed	Not adequate	Slight	Sediment trap / mulching	$500 acre/mulch $1.75 ft/ silt fence	$1,525.	Picture avail, large piles of dirt a few feet from lake w/ small silt fence, **4 such sites around Gun Lake**
														Total for all sites	**$1,525.**	

Other recommendations for riparian land owners:

- Remove all signs of vegetation from boats and trailers before leaving access.
- Thoroughly wash boat and trailer with bleach and hot water before moving to another water body or leave boat dry docked for 7 to 10 days.
- Do not feed geese or other waterfowl.
- Remove pet or waterfowl waste from lawn.
- Be knowledgeable and aware of exotic species transport to prevent further spread throughout the watershed.

The following management goals were set forth in the MDNR study in 1991. Enhancing the sport fishery in Gun Lake could be accomplished by implementing the following recommendations:

- Conduct full fisheries surveys every 10 years.
- Muskellunge stocking should not be resumed.
- Continue the cooperative rearing agreement for walleyes with the Gun Lake Protection Association (GLPA).
- Evaluate the possible natural reproduction of walleye.
- Encourage GLPA to pursue boating regulations for the lake, such as slow or no-wake periods for early evening to early morning.

CHAPTER 6 - COMMUNITY OUTREACH PLAN

The Community Outreach Plan (Outreach Plan) was developed to guide watershed activities and focus appropriate attention on issues formulated by the Steering Committee during the planning process. Stakeholders in other watershed project areas were contacted for advice about their own successes with various methods of outreach. The strategies outlined in the Outreach Plan are designed to be the foundation of an outreach effort that can continue to be modified as issues and opportunities emerge. The Steering Committee developed a broad framework which includes goals, objectives, overall messages, and elements that connect all aspects of outreach activities. Key audiences are defined and specific actions for each audience are described in this chapter. Products and events resulting from implementing the Outreach Plan are summarized in Table 6.1.

6.0 KEY AUDIENCES

Township, city, and village officials
Agricultural producers
Riparian landowners/homeowners
County government officials (drain commissioner, road commission, soil erosion enforcement agency)
Stakeholders
Lake residents-Gun Lake and other small lakes

6.0.1 GOALS FOR THE GUN RIVER WATERSHED COMMUNITY OUTREACH PLAN

Build and retain high levels of stakeholder awareness and involvement in the Watershed project so that community values related to stewardship for the Gun River can be sustained.

Promote ongoing participation of Watershed residents in activities which benefit the Watershed and water quality.

Build awareness of watershed residents' responsibility for how their individual practices and activities affect water quality that flows across their land.

6.0.2 OVERALL OUTREACH OBJECTIVES

To build and retain community awareness of the following issues: watershed recognition, understanding of how water quality can be degraded, and knowledge of watershed-friendly land use practices.

To encourage the adoption of BMPs that protect and/or improve water quality and flow regime of the Gun River.

To maintain existing partnerships and identify additional partnerships to increase awareness of and involvement in the Watershed.

To raise awareness that wetlands are beneficial to protecting water quality and are valuable ecosystems for wildlife.

To encourage local officials to use the Watershed Management Plan (WMP) as a tool for land-use planning in their townships.

6.1 OVERALL KEY MESSAGES

Protecting the Gun River is protecting property values.

Wetlands are wonderful.

6.2 OUTREACH TOOL BOX

The tool box contains communications materials that are essential to the success of the community outreach efforts.

Gun River Watershed Project Logo - A Gun River Project logo has been created to connect communications about watershed activities to the project and to increase awareness.

General Information Brochure - A simple, self-mailer brochure containing general information about the Watershed (definition, goals, practices) will be developed. The brochure will include the logo, contact information, and relevant graphics. The brochure should be easy to read and be eye-catching.

Website - The Watershed website serves as an educational and informational tool for the public to learn about the watershed project in one convenient place. The web site should be linked to appropriate sites to expand the potential audience.

Newsletter - A two- to four-page newsletter to be distributed to stakeholders. The newsletter will include updates about project activities, partners, ways for others to become involved, and timely information (i.e., spring could highlight proper lawn fertilization procedures).

Gun River Watershed Signage - Create signs (12- by 24-inch) featuring the Watershed Logo or other distinctive watershed oriented symbol such as the Kalamazoo River/Lake Allegan Watershed logo which indicates that YOU ARE In the Watershed. Signage will also be placed at indicated sites with Best Management Practices (BMPs). The signs will raise awareness of stakeholders' geographical connection to the Watershed and will make the progress and accomplishments of the Watershed project more visible to the public.

Enviroscape Model - Purchase an EnviroScape model for use at events, schools, and libraries to demonstrate watershed concepts, and raise awareness of the Watershed.

Gun River Watershed Permanent Display - Develop a permanent display about the Watershed that can be hosted on a rotating basis at local libraries and schools.

Gun River Watershed Seal/Certificate - Develop a certificate or seal for the Watershed to be given to local units, producers, and residents who adopt practices outlined in the WMP.

6.2.1 TOWNSHIP, CITY, AND VILLAGE OFFICIALS

6.2.1.1 OBJECTIVES

To foster a sense of ownership and investment in the Watershed project among area officials and planning commissions.

To increase understanding and support of low impact development techniques to protect water quality.

To raise awareness of conservation easements and Purchase of Development Rights (PDR) as options to preserve open lands, farmland, wetlands, and high quality upland areas in the Watershed.

To encourage using the WMP as a tool for land-use planning decisions, and the development of model ordinances that protect water quality.

6.2.1.2 ACTIVITIES

Develop Appropriate Technical Information in a useable format (maps, reports, electronic media) to support water quality protective ordinances and land-use planning strategies. This information includes the Hydrologic and Hydraulic Analysis model results where appropriate. Develop a modified scoring process similar to the Land Evaluation and Site Assessment (LESA) method for determining appropriate land use. The process would incorporate the technical information compiled in this WMP. Prepare maps using existing data that would consist of overlays on a township scale that depict storm water management areas, BMP areas, and flood management areas.

Workshop - Host relevant workshop/tour for local government officials to highlight land use planning strategies to protect water quality. Host a workshop or short course designed to assist local units of government with the use of the WMP for land use decision making.

Citizen Planner Course - In partnership with Michigan State University Extension (MSUE) - Allegan present a Citizen Planner Course for Allegan County and Barry County residents/township officials to encourage using watershed management strategies in land-use planning activities and raise awareness of watershed issues. Specifically include a discussion about how local officials can use a WMP for the aforementioned purpose.

Gun River Watershed Certificate/Seal - Award certificate/seal to individuals who regularly attend steering committee meetings, complete the watershed short course, and/or implement BMPs.

6.2.2 AGRICULTURAL PRODUCERS

6.2.2.1 OBJECTIVES

To increase the amount of agricultural producers that plant windbreaks, filter strips, grassed waterways, and utilize residue management.

To increase the amount of producers using a comprehensive nutrient management plan and to decrease the amount of producers that allow their livestock access to surface water.

To increase awareness about benefits and availability of conservation easements and farmland preservation programs.

To increase the attendance of agricultural producers at workshops, presentations, and training sessions on land use practices that benefit water quality.

6.2.2.2 ACTIVITIES

Articles in Specialty Publications - Educational and informational articles to appear in county specific publications that target this audience (such as Farm Service Agency, MSUE newsletters). Articles would highlight services to agricultural producers to assist them in implementing BMPs.

Develop Partnerships with Agricultural Service Providers - Develop partnerships with equipment dealers, grain elevators, and feed stores. Distributing information through information stands at these businesses to farmers about fertilizers, soil testing, and nutrient management during the spring.

Show Participation - Participate in area events such as the Allegan County Fair, events at Kellogg Biological Station, and other events that feature agricultural education opportunities. Representatives will set up a booth or host a presentation at the event with relevant project information including the logo, brochure, newsletters, and watershed maps.

Comprehensive Nutrient Management Field Day - Coordinate with Michigan Department of Agriculture and MSUE to host a field day to highlight current nutrient management practices and opportunities for assistance.

Comprehensive Nutrient Management Planning - Promote the development of Comprehensive Nutrient Management Plans for watershed livestock producers through information dissemination and workshops. Utilize the Progressive Planning process to encourage high rates of participation by the agricultural community. Partner with MSUE, MAEAP, MDA and Farm Bureau to implement Progressive Planning as a step-wise process to work towards CNMPs.

Partner with the Michigan Agriculture Environmental Assurance Program (MAEAP) - To increase awareness of this program and assistance available to producers.

Promote And Provide Information About New Farm Bill Programs that have technical and financial assistance for BMPs that protect water quality. Anticipated programs include the Environmental Quality Assistance Program (EQIP), Wildlife Habitat Incentive Program (WHIP), Wetland Reserve (WRP), and Conservation Reserve Programs (CRPs).

Partner with the Michigan Farm Alliance and the Southwest Michigan Land Conservancy to promote Conservation Easement and Purchase of Development Rights. Host workshop about easements, PA116, Purchase of Development Rights, and other land preservation options. Highlight benefits to landowner and township residents.

Host workshop about low impact development and the benefits to neighboring landowners. May combine topic with conservation easement workshop. This event would target large acreage landowners.

6.2.3 RIPARIAN LANDOWNERS/HOMEOWNERS

6.2.3.1 OBJECTIVES

To increase awareness and adoption of water quality protective lawn care, and yard maintenance practices, especially for riparian land owners.

To highlight the benefit of wetlands for wildlife, to reduce flooding, and protect water quality.

To increase awareness of the value of the Gun River to local quality of life.

6.2.3.2 ACTIVITIES

Gun River Clean-Up Day - Host a Clean-Up Day to pick up trash and litter in and near the Gun River. Involve local Boy Scout, Girl Scouts, alternative high schools, and other groups to participate. Record event with digital camera and display pictures on website to demonstrate community involvement.

Event Participation - Host a booth at the Plainwell Island Festival and the Allegan County Fair to raise awareness about the Watershed project. Have watershed display and host a demonstration with the EnviroScape model.

Homeowner Demonstration Site - Develop a demonstration site that highlights shoreline/streambank friendly landscaping practices that also protect water quality. Record progress with digital camera and

display pictures on website and at the booth. This site could also be part of a watershed tour during the implementation phase of the Watershed project.

History of the Gun River - Prepare a short history of the Gun River to be published in local papers to demonstrate its importance to the community and raise awareness of the value of the Gun River to local quality of life.

Develop a Partnership with Local Libraries and Schools to host the watershed display and general brochures on a rotating basis. Also have a copy of the WMP available in local libraries.

Develop a Student Stream Monitoring Program for area schools. Provide technical assistance and support for program. Coordinate efforts with the Allegan County Math and Science Center. Select accessible sites on the Gun River or its tributaries. Provide a watershed sign to participating schools.

Develop a Soil Testing Program (lawns and gardens) - Working with area schools and MSUE - develop a program to have students collect a soil sample from their lawns and have the sample brought to school. Have soil analyzed by MSUE and results sent to students. Teachers and students would review results and discuss needed actions. Include information about non-phosphorus fertilizer sources and good lawn care practices. Distribute existing information, such as is available from the TMDL Turfgrass Committee and MSUE Turf Tips, about lawn care and soil testing.

Newsletters, Articles - Include information about low or non-phosphorus fertilizers for lawns and promote soil testing. Highlight student activities as a way to encourage these activities.

Gun River Watershed Certificate/Seal - Award - Certificate to residents who soil test and follow lawn care guidelines.

Wetland Brochure and Wetland Tour - Develop a brochure about wetlands in the Watershed. Host a tour of local wetlands and highlight the importance of wetlands for wildlife and protecting water quality, and demonstrate wetlands as areas to retain storm water to reduce flooding.

Citizen Planner Course - Encourage local residents to attend Citizen Planner Course to raise awareness about land-use decision making process and how to incorporate new techniques for protecting open space, low impact development.

Shoreline Landscaping Demonstration Workshop - Host a workshop at the shoreline native plant landscaping demonstration site at Kellogg Biological Station and have experts discuss how to apply techniques in the Gun River Watershed. Also highlight the Landscaping for Water Quality Brochures.

Partner with the Kalamazoo River/Lake Allegan TMDL project to host a “Kanoe Kazoo” event on the Gun River. This would be a “Kanoe Kazoo” tributary trip with a Gun River clean-up component.

6.2.4 LOCAL GOVERNMENTAL UNITS

6.2.4.1 OBJECTIVES

To raise awareness of BMPs that could be implemented to reduce erosion.

To increase coordination between agencies to maximize benefits of available programs and protect water quality.

6.2.4.2 ACTIVITIES

Coordinate Meetings - Host working group meetings with agencies to discuss ways to incorporate BMPs in construction projects and opportunities for the agencies to apply for cost-share programs.

Demonstration Sites - Develop demonstration sites that highlight the effectiveness of BMPs in protecting water quality and the benefits of these practices in reducing costs to the agency in decreased maintenance.

Watershed Tour - Host a watershed tour to highlight project activities and show new techniques for streambank stabilization. Focus on practices installed on, in, or near county drains.

Promote Awareness of the Watershed Management Plan and the technical information available in this plan about the Watershed, hydrologic, and hydraulic studies.

Watershed Sign - Use Watershed signs to highlight installed BMPs.

Citizen Planner Course - Encourage local units to attend Citizen Planner Course to raise awareness about the land-use decision making process and how to incorporate new techniques for protecting open space, low impact development.

Wetland Brochure and Wetland Tour - Develop a brochure about wetlands in the Watershed. Host a tour of local wetlands and highlight the importance of wetlands for wildlife and protecting water quality, and demonstrate wetlands as areas to retain storm water to reduce flooding.

6.2.5 STAKEHOLDERS

6.2.5.1 OBJECTIVES

To increase the level of participation among stakeholders through increased meeting attendance and regular attendance.

To keep stakeholders involved in protecting water quality even after the grant ends.

6.2.5.2 ACTIVITIES

Develop a Watershed Organization - Develop a “Friends of the Gun River” to monitor activities that affect water quality, environmental issues, and recreational uses. This organization could also create an Adopt-A-Stream program.

Project Website - Announce meeting dates on the project website and have the website address visible on project literature.

Meeting Mailings - Maintain and expand stakeholder mailing list to be used for communication about meetings and project status.

6.2.6 LAKE RESIDENTS

6.2.6.1 OBJECTIVES

To increase awareness and adoption of water quality protective lawn care, and yard maintenance practices, especially for lakeshore land owners.

To increase awareness of the value of the Gun River to local quality of life.

6.2.6.2 ACTIVITIES

Develop Partnerships with Lake Associations - Develop a list of lake associations, contacts, meeting dates, and newsletters.

Newsletters, Articles - Include information about low or non-phosphorus fertilizers for lawns and promote soil testing. Target publications such as the Gun Laker Magazine.

Develop a Soil Testing Program (lawns and gardens) - Working with area schools and MSUE - develop a program to have students collect a soil sample from their lawns and have the sample brought to school. Have soil analyzed by MSU and results sent to students. Teachers and students would review results and discuss needed actions. Include information about non-phosphorus fertilizer sources and good lawn care practices. Distribute existing information about lawn care and soil testing.

Develop a Volunteer Monitoring Program for Gun Lake (and others) - The lake associations would be the focal point for this program and would work with the health department to provide assistance with monitoring lake water quality.

Gun River Watershed Certificate/Seal - Award certificate to residents who soil test and follow lawn care guidelines.

Post Informational Signs About Invasive Species and the importance of cleaning your boat and bait bucket to prevent their spread.

Wetland Brochure and Wetland Tour - Develop a brochure about wetlands in the Watershed. Host a tour of local wetlands and highlight the importance of wetlands for wildlife and protecting water quality, and demonstrate wetlands as areas to retain storm water to reduce flooding.

Table 6.1 - Community Outreach Plan Products and Events

Item or Activity	Audience	Lead Agency	Completed	Estimated Cost
Gun River Watershed logo	All	ACD, Steering, and Partners	Yes	N/A
General information brochure[1]	All	ACD, Steering, and Partners	No	$650
Lawn care brochure	Riparian landowners, homeowners, stakeholders, and lake residents	ACD, Steering, and Partners	No	$450
Agricultural brochure	Agricultural producers	ACD, Steering, and Partners	No	$450
Land-use brochure	Township, city, village, and government officials	ACD, Steering, and Partners	No	$450
Landscaping for water quality brochure	CES and MDEQ	ACD, Steering, and Partners	Yes	N/A
Wetlands are Wonderful brochure	All	ACD, Steering, and Partners	No	$450
Website	All	Volunteers	No	$50
Township maps for land use[2]	Township, city, village, and government officials	FTC&H, Allegan land information office, ACD	No	Contractual
Checklist for land evaluation[2]	Township, city, village, and government officials	Consultant, ACD	No	Contractual
Newsletter[1]	All	ACD, Steering, and Partners	No	$650
Gun River Watershed signs[3]	All	ACD, Steering, and Partners	No	$250 (each)
Gun River Watershed certificates/seal	All	ACD, Steering, and Partners	No	$100
Gun River Watershed display	All	ACD, Steering, and Partners	No	$2,700
EnviroScape model	Riparian landowners, homeowners, stakeholders, and lake residents	ACD, Steering, and Partners	No	$2,000
Citizen planner course	Riparian landowners, lake residents, township, city village, and government officials	MSU Extension-Allegan	No	$500
Allegan County Fair and Plainwell Island City festival	All	ACD, Steering, and Partners	Continuing	$450
Workshops, field day and watershed tour and wetland tour	Selected audiences	ACD, Steering, and Partners	No	$400 (Tour)
Comprehensive easements/PDR workshop	Township officials, large acreage landowners	Michigan farm alliance, SWMLC, ACD	No	$500

Table 6.1 - Community Outreach Plan Products and Events

Item or Activity	Audience	Lead Agency	Completed	Estimated Cost
Low impact development workshop	All may have multiple workshops focused on specific audience	ACD, Steering, and Partners	No	$600
Shoreline landscaping demonstration	Riparian landowners and lake residents	ACD and MSUE Kellogg Biological Station	No	$500
Kanoe Kalamazoo (canoe event)	Riparian landowners, stakeholders and local units	ACD, MSUE Kellogg Biological Station, Kalamazoo River Watershed project, Downstreamers	No	$300
Comprehensive nutrient management field day	Agricultural producers	ACD, Steering, and Partners	No	$200
Student stream monitoring program	Riparian landowners homeowners, stakeholders, and lake residents	ACD, Allegan Math and Science Center	No	$200
Student lawn/garden soil testing/care program	Riparian landowners homeowners, stakeholders, and lake residents	ACD, MSUE Kellogg Biological Station, Allegan Math and Science Center	No	$500
Watershed organization- "Friends of the Gun River"	All	Steering and Partners	No	$200
Articles in specialty publications	Selected	Steering and Partners	No	$100 (each)
Volunteer monitoring/Adopt-A-Stream for Gun River[4]	Riparian landowners	ACD, MDEQ, WMEAC	Continuing	$200
Volunteer monitoring program for Gun Lake[4]	Lake residents	Lake Association	No	$300 (for mailing)
Develop partnerships with local organizations	Selected	ACD and Steering	No	
Steering Committee meetings[5]	All	ACD	No	$60/Meeting

1 - Costs include printing and postage for 500 items, assumes in-house design
2 - Costs are included under the contractual budget category
3 - Volume discounts may lower price
4 - Cost of mailing information to raise awareness of program
5 - Meeting space

It should be noted that the Outreach Plan outlines a dynamic process that will require adjustments as implementation moves forward. The Outreach Plan is a starting point that provides a guide for outreach actions. Many topics such as low impact development are continuing to propose new more effective techniques. Other water quality projects are occurring in the Kalamazoo River Watershed and provide opportunities to develop new partnerships and host joint workshops/events. The stakeholders in the Watershed will have the flexibility to suggest adjustments in the Outreach Plan and take advantage of future opportunities.

6.3 PUBLIC PARTICIPATION PROCESS

The Gun River Watershed Project began with a concerned citizen who formed a small group of like-minded individuals, they held clean-ups and canoeing events, attended other water quality initiative meetings, and demonstrated a commitment to improving water quality in the Gun River.

The Allegan Conservation District submitted a Section 319 Grant Proposal on behalf of the concerned citizens. The MDEQ funded the project in June 2001. The resulting planning project included public participation by forming a Steering Committee to provide direction for the project.

A stakeholder mailing list was developed based on information provided by the original group, the drain commissioner, and interested parties. Fourteen Steering Committee meetings and four small group technical meetings were held. Countless one-on-one discussions were held with individual stakeholders. Meetings were held prior the grant start date and are anticipated to continue periodically after the planning project ends.

Information about the project was disseminated several ways, through update letters, project newsletters, and articles in other publications. These publications include the Penasee Globe, Gun Laker Magazine, Farm Service Agency Newsletter, Michigan State University Extension Newsletter, Gun River Watershed website (now part of the Allegan Conservation District Website at allegancd.org), Allegan Conservation District newsletter, and Allegan County News. Project information was displayed at events such as the Allegan County Fair, and the Plainwell City Island Festival.

In the winter and spring of 2002, in partnership with the Gun River Watershed Project, MSUE held Phase I meetings in Martin Township. The Phase I meetings were for agricultural livestock producers to explain the new requirements and processes for manure management. These were held as two small group meetings in Martin Township to address this issue. In addition, as part of the Kalamazoo River Lake Allegan TMDL agricultural BMP selection/monitoring process, a small group meeting of agricultural producers was held to discuss various BMPs, obstacles to implementation, what practices are viewed by producers as cost-effective, and how to measure the results of BMP implementation.

Steering Committee and Stakeholders

The Steering Committee and involved stakeholders were an integral part of project. Through their various areas of expertise, members have discussed and evaluated a planning process to develop a guide for improving water quality in the Watershed. To date, the following participants have been involved in the

watershed planning process. Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) was the consultant for the project to provide technical support and to develop the plan and H&H study.

Mr. Don Brown	Kalamazoo Environmental Council
Mr. Doug Carter	MSUE Kellogg Biological Station
Ms. AnneMarie Chavez	Allegan Conservation District
Mr. Carl Collier	Allegan Conservation District
Mr. Duane Denniston	Resident
Mr. Dennis DeYoung	Resident
Mr. Thomas Dunn	City of Otsego
Mr. Tom Doyle	Barry County Drain Commissioner
Mr. Lynn Fleming	Allegan County Drain Commissioner
Ms. Jane Herbert	MSUE Kellogg Biological Station
Mr. Gregory Jaynes	Resident
Ms. Ruth Jaynes	Resident
Ms. Julia Kirkwood	MDEQ
Mr. Ron Kopka	Gun Plain Township Trustee
Mr. Glenn Leep	Martin Township
Mr. Wes Leep	Resident
Mr. Cary Mannaberg	Resident
Ms. Jenny Molloy	MDEQ
Mr. Robert H. Monroe	Gun Lake Sewer Authority
Mr. William Nelson	Allegan County Road Commission
Ms. E. Wendy Ogilvie	FTC&H
Ms. Diane Hornbrook	FTC&H
Ms. Claire Schwartz, P.E.	FTC&H
Mr. William Semeyn	USDA Natural Resources Conservation Service
Mr. Dave Vande Bunte	Resident
Dr. Jereon Wagendorp	Land and Information Services Allegan County and Resident
Mr. Jay Wesley	Michigan Department of Natural Resources
Mr. Skip Whitney	Gun Plain Township Supervisor
Mr. Paul Wylie	Michigan State University Extension

CHAPTER 7 - IMPLEMENTATION STRATEGIES

7.0 GOALS AND OBJECTIVES FOR THE GUN RIVER WATERSHED

The implementation of this Watershed Management Plan (WMP) requires a combination of strategies that include community outreach/education, construction/installation of Best Management Practices (BMPs) to prevent or correct degradation of water quality due to nonpoint sources (NPS), and institutional management - land use planning ordinances protective of water quality. The goals of the Watershed community to improve water quality to meet designated uses will not be realized without this multi-faceted approach. The Gun River Watershed (Watershed) encompasses diverse communities that may require different areas of emphasis to meet local needs while coordinating their efforts with neighboring jurisdictions.

The foundation for all change is to raise awareness about the problem, about the solution, and to gain consensus on how to move from discussion of the issues to measurable results. The specific outreach steps, audience, and objectives are presented in Chapter 6. The next two steps, construction of BMPs and land use planning, will be described in this chapter.

BMPs are designed to prevent or reduce NPS pollution. Degraded water quality in the Watershed is a clear indication that installing BMPs is essential to solving this issue especially within the next ten years or less.

Land use planning strategies at the township, city, and village level will offer longer-term institutional management for the prevention of additional impact to water quality through human activities. Local units within the Watershed have a diverse range of demographics. For example, Wayland and Gun Plain Townships have experienced population growth between 17% and 28% (1990 to 2000) and Martin Township experienced 9% to 1.9% growth in the same time period. Population shifts, current land use patterns, and natural features vary throughout the Watershed, which means that different areas within the Watershed may require different strategies to address water quality issues. Part of the implementation process will include tailoring the overall watershed management strategies to meet the specific needs of local stakeholders.

The Steering Committee defined the goals and objectives for the Watershed at a working meeting on April 25, 2002. A summary of the impairments to the designated uses was presented to the committee. The committee members also examined the inventory results to determine which pollutants were most abundant and what impact those pollutants had in the Watershed. The committee members were assigned the task of completing a worksheet to determine the goals and objectives that would address

the impairments. Once the goals were established, the committee formulated specific objectives to meet each of the goals. The objectives were further identified in categories of either BMPs or Land Use Planning. The goals and objectives are included in Table 7.1.

The community and the Steering Committee expressed concerns over many other conditions in the Watershed that were not directly related to water quality. Table 7.2 describes the goals and objectives that were developed for the desired uses.

Table 7.1 - Goals and Objectives for the Gun River Watershed

Pollutants and Impairments To Designated Uses	Goal	Objectives
SEDIMENT High - Agriculture High - Warmwater Fishery High - Coldwater Fishery High - Indigenous Aquatic Life and Wildlife	Reduce soil erosion and sedimentation by 10% of the loadings every year	**Best Management Practices** Use more preventative measures rather than remediation efforts. Increase use and quality of filter strips and windbreaks. Encourage farmers to use cover crops and promote no-till farming. Review SESC inspections and enforcement procedures. Encourage farmers to request and implement Highly Erodible Land (HEL) conservation plans on HEL land through the Natural Resources Conservation Service. **Land Use Planning** Improve storm water management techniques through ordinances or site design criteria. Develop model ordinances or other mechanisms for high risk erosion areas, shoreline setbacks, greenbelts, slope protection, open space, and storm water management. Apply open space and conservation easements to areas with high erosion potential, not suitable for other land uses, to protect venerable slopes. Implement low impact development strategies. Develop overlay maps that show areas with high potential storm water runoff where construction techniques that allow more infiltration of storm water to reduce high discharge runoff and the resulting erosion should be applied.
NUTRIENTS High - Indigenous Aquatic Life and Wildlife High -Total Body Contact Recreation (Gun Lake) Medium - Total Partial Body Contact Recreation (Gun River) Medium - Total Partial Body Contact Recreation (Gun Lake) Medium - Total Body Contact Recreation (Gun River) Low - Warmwater Fishery Low - Coldwater Fishery	Reduce phosphorus by 10% of the loadings and nitrogen by 5% of the loadings every year and establish TMDLs in designated areas	**Best Management Practices** Use systems approach on farms with conservation planning and comprehensive nutrient management plans. Increase technical support and funding opportunities for implementing conservation programs. Educate homeowners and lawn care companies to use less fertilizers on lawns. Address residential septic systems. Educate homeowners about composting to reduce dumping of leaves and yard waste into streams. **Land Use Planning** Examine wildlife management strategies near surface waters. Develop model ordinances or other mechanisms for residential fertilizer use, yard waste disposal options, septic tanks, slope protection, shoreline setbacks, greenbelts, soil erosion, and storm water management. Implement low impact development strategies that include promotion of low impact landscaping in residential areas (plants that do not require fertilizer). Develop overlay maps that show where shoreline (streambank, lakeshore, drain easement) areas are located to reduce use of phosphorus fertilizer. Conduct septic system inspections.
HYDROLOGY High - Navigation High - Coldwater Fishery Medium - Agriculture Medium - Warmwater Fishery Medium - Partial Body Contact Recreation	Stabilize stream flows to moderate hydrology and increase base flows	**Best Management Practices** Use peak flow rates and water surface elevations from hydrologic analysis as basis for in-stream modifications. **Land Use Planning** Integrate map of flood prone areas with Allegan County LIS to regulate development within floodplain. Use hydrologic analysis to expedite regular participation in the FEMA Flood Insurance Program.

Table 7.1 - Goals and Objectives for the Gun River Watershed

Pollutants and Impairments To Designated Uses	Goal	Objectives
		Encourage storm water detention policy that allows no more than 0.06 cfs/acre of development to be discharged to the Gun River. Implement low impact development techniques and qualitative storm water design criteria. Include innovative storm water management practices in county storm water rules and township land use ordinances. Apply conservation, farmland, and open space easements for infiltration and storm water storage areas to reduce the volume and velocity of storm runoff. Develop model ordinances or other mechanisms for floodplain management, high risk erosion areas, shoreline setbacks, greenbelts, storm water management, farmland and open space preservation, and wetland protection.
OBSTRUCTIONS High - Agriculture High - Navigation High - Partial Body Contact Recreation	Manage obstructions	**Best Management Practices** Clear obstruction in areas that are blocking flow and causing flooding on agricultural lands. Clear obstruction for navigation and recreation or keep obstructions for habitat where appropriate.
E. COLI High - Agriculture High - Partial Body Contact Recreation (Gun Lake) High - Total Body Contact Recreation (Gun Lake) Low (s) - Partial Body Contact Recreation (Gun River) Low (s) - Total Body Contact Recreation (Gun River)	Prevent *E. coli* from entering surface waters and attain water quality standards for Total Body Contact Recreation from May 1 to October 1 in Gun Lake	**Best Management Practices** Encourage testing and selective monitoring for *E. coli* in high risk areas. Create volunteer monitoring program. **Land Use Planning** Develop model ordinances or other mechanisms for shoreline setbacks, green belts, slope protection, storm water management, and wetland protection.
TEMPERATURE High - Coldwater Fishery Medium - Warmwater Fishery	Maintain coldwater fishery	**Best Management Practices** Encourage drain maintenance projects to remove trees on only the north and west sides of drain to provide shade for stream. **Land Use Planning** Adopt site design criteria that minimize impervious surfaces, promote infiltration to increase base flow, and maintain riparian corridors, according to low impact development principles. Develop model ordinances or other mechanisms for shoreline setbacks, greenbelts, slope protection, storm water management, and wetland protection.
HYDROCARBONS AND OTHER CONTAMINANTS Low - Other Indigenous Aquatic Life and Wildlife	Reduce potential for hydrocarbon contamination	**Best Management Practices** Improve efficiency and maintenance on irrigation pumps. Evaluate the use of electric or solar powered pumps. Assess fuel storage facilities through Farm*A*Syst program. **Land Use Planning** Improve storm water management to reduce runoff.
INVASIVE AND EXOTIC SPECIES Medium - Other Indigenous Aquatic Life and Wildlife Low - Agriculture	Minimize spread of invasive and exotic species	**Best Management Practices** Investigate effective techniques to control Eurasian watermilfoil, purple loosestrife, and zebra mussels.

Table 7.1 - Goals and Objectives for the Gun River Watershed

Pollutants and Impairments To Designated Uses	Goal	Objectives
HABITAT FRAGMENTATION Low - Other Indigenous Aquatic Life and Wildlife	Minimize habitat fragmentation	**Best Management Practices** Encourage riparian buffers through proper drain maintenance. **Land Use Planning** Encourage riparian buffers through buffer ordinances. Encourage responsible land use planning through adoption of low impact development techniques and education of local officials. Develop model ordinances or other mechanisms for greenbelts, farmland and open space protection, and wetland protection. Promote conservation, farmland, and open space easements to protect habitat.

High = High Priority Impairment
Medium = Medium Priority Impairment
Low = Low Priority Impairment
(S) = Suspected

Table 7.2 - Goals and Objectives for Desired Uses

Desired Use	Goals	Objectives
Groundwater use as private drinking water source	Ensure safe and reliable groundwater for drinking water use	Reduce nitrogen inputs to groundwater by implementing nutrient management programs.
Increase recreational opportunities	Add public access sites in the Gun River Watershed	Create at least one “barrier free” site for access to the Gun River for canoeing or kayaking.
Preserve open space and rural character	Use planning techniques to manage growth	Conduct workshops and educational programs about planning tools that Townships can use to manage growth.
Create a Gun River Trailway	Build a trail along Gun River for recreational and informational use	Follow example of the Kalamazoo River Valley Trailway, including interpretive signs, to provide the same opportunities to the Gun River Watershed communities.
Protect prime farmlands	Protect prime farmland and agricultural way of life for future generation.	Protect prime farmland with land use planning ordinances, policies, and tax incentives.
Protect unique habitats for endangered species	Maintain diversity in Watershed	Protect habitats with resource-based land use planning policies and educate the public about the unique resources.
Encourage wildlife habitats	Assist land owners in enhancing properties for wildlife habitats	Inform the public about the many opportunities available for wildlife habitat establishment and protection.

7.1 WATER QUALITY SUMMARY

The water quality of the river, lakes, and streams in the Watershed is afflicted by NPS pollution. The Gun River is a tributary to the Kalamazoo River, which has been placed on the MDEQ's 303(d) non-attainment list of impaired waters. Identified pollutants include phosphorus, of which the Gun River is the third highest contributor to the Kalamazoo River/Lake Allegan system. Biological surveys conducted by the MDEQ found area in the Watershed with poor macroinvertebrate communities due to excessive sedimentation. A portion of the Gun River near its mouth is identified as a coldwater fishery, supporting a trout habitat that has been sustained with annual fish stocking by the MDNR. Land use activities that increase storm water runoff intensify NPS pollution problems in the Watershed. The following summary links the problem sites and sources that are impairing the water quality to the goals and objectives of restoring the designated uses of the Watershed. The impairments are listed in order of highest to lowest priority in the Watershed.

Pollutant/Impairment:

Sediment

Impairment to Designated Uses:

Sediment is a high priority impairment to agriculture, warmwater fishery, coldwater fishery, and other indigenous aquatic life and wildlife. Sediment can interfere with the efficient functioning of irrigation systems. Excess sediment covers riffles, destroys spawning habitat, and causes turbidity.

Sources:

Sediment comes from both upland and in-stream sources. Cropland, construction sites, gullies, and stream crossings were identified as sources.

Causes:

Conventional tillage practices that leave soil exposed to water and wind erosion cause erosion. Exposed soil erodes from construction sites where proper SESC practices are not installed or maintained. Active gully erosion on fields without filter strips or stabilized outlets adds sediment to the stream. Unrestricted livestock and vehicle access to the stream causes streambank erosion.

Goals:

Reduce soil erosion and sedimentation by 10% of the loadings every year.

Objectives:

Best Management Practices

- Use more prevention measures than remediation efforts.
- Increase use and quality of filter strips and windbreaks.
- Encourage farmers to use cover crops and promote no-till farming.
- Encourage farmers to request and implement Highly Erodible Land (HEL) conservation plans on HEL land through the Natural Resources Conservation Service.
- Review SESC inspection and enforcement procedures.

Land Use Planning

- Improve storm water management techniques through ordinances and site design criteria.
- Develop model ordinances or other mechanisms for high risk erosion areas, shoreline setbacks, greenbelts, slope protection, open space, and storm water management.
- Apply open space and conservation easements to areas with high erosion potential, not suitable for other land uses, to protect venerable slopes.
- Implement low impact development strategies.
- Develop overlay maps that show areas with high potential storm water runoff where construction techniques that allow more infiltration of storm water to reduce high discharge runoff and the resulting erosion should be applied.

Pollutant/Impairment:

Nutrients

Impairments to Designated Uses:

Nutrients are high priority impairments to total body contact recreation in Gun Lake. They are medium priority impairments to partial and total body contact recreation in the Gun River and partial body contact recreation in Gun Lake. Nutrients are low priority impairments to warm and coldwater fisheries. Excess nutrients, such as phosphorus and nitrogen, cause eutrophication, a cycle which depletes oxygen and increases plant growth to an extent where many species cannot survive. Algae grows at a rapid rate due to the excess nutrients. The algae settles on slow moving stream bottoms as it dies and forms a thick layer of organic matter. The decomposition process depletes oxygen, causing anoxic conditions which creates methane. The process destroys the balance of water chemistry and food webs. Several waterbodies in the Watershed are on the 303(d) non-attainment list to develop a TMDL for phosphorous.

Sources:

Nutrients in fertilizers used in agricultural applications, residential applications, and landscaping enter the watercourses in storm water runoff. Nutrients concentrated in human and animal wastes are introduced into surface waters through leaking manure storage area, failing septic systems, and direct discharges or runoff. Large concentrations of wildlife, such as geese, can also be sources of nutrients. Yard waste, especially leaves and grass clippings, dumped in the waterways decompose quickly into available nitrogen and organic matter, adding to the nutrient levels.

Causes:

Improper fertilizer and manure application and storage allow nutrients to enter surface water and groundwater. Septic system failures and direct discharges have been a problem in Gun Lake, but the creation of the Gun Lake Sewer and Water Authority has made great strides to the resolution of this cause. Populations of waterfowl in and around Gun Lake have not been shown to cause a significant amount of nutrient loading at their current population levels, but are a potential cause of excessive nutrients. Yard wastes piled on the banks of the Gun River and the shores of Gun Lake blow directly into the water adding nutrients.

Goal:

Reduce phosphorus by 10% and nitrogen by 5% of the loadings every year and establish TMDLs in designated areas.

Objectives:

Best Management Practices

- Use systems approach on farms with conservation planning and comprehensive nutrient management.
- Increase technical support and funding opportunities for implementing conservation programs.
- Educate homeowners and lawn care companies to use less fertilizers on lawns.
- Address residential septic systems.
- Educate homeowners about composting to reduce dumping of leaves and yard waste into streams.
- Conduct septic system inspections.

Land Use Planning

- Examine wildlife management strategies near surface water.

- Develop model ordinances or other mechanisms for residential fertilizer use, yard waste disposal options, septic tanks, slope protection, shoreline setbacks, greenbelts, soil erosion, and storm water management.

- Implement low impact development strategies that include promotion of low impact landscaping in residential areas (plants that do not require fertilizer).

- Develop overlay maps that show where shoreline (streambank, lakeshore, drain easement) areas are located to reduce use of phosphorus fertilizer.

Pollutant/Impairment:

Hydrology

Impairment to Designated Uses:

Hydrology is a high priority impairment to navigation and coldwater fishery. It is a medium priority impairment to agriculture, warmwater fishery, and partial body contact recreation in the Gun River. Changes in flow affect water levels and the rate of water movement. Flashy flows, signified by swift moving high water shortly after a rain and very low levels during dry periods, can be the result of increased artificial drainage. Changes in land use can increase flooding, erosion, and sedimentation.

Sources:

Alteration of drainage patterns and changes in land use affect the natural hydrology of a stream.

Causes:

Establishment and improvements of drains, elimination of wetlands, and increases of impervious surfaces destabilize hydrology.

Goal:

Stabilize stream flows to moderate hydrology and increase base flows.

Objective:

Best Management Practices

- Use peak flow rates and water surface elevations provided by hydrologic analysis as the basis for any in-stream modifications.

Land Use Planning

- Integrate map of flood prone areas with the Allegan County LIS to regulate development within the floodplain.

- Use hydrologic analysis to expedite regular participation in the FEMA Flood Insurance Program for Otsego and Gun Plain Townships through a partnership between Allegan County and FEMA.

- Encourage storm water detention policy that allows no more than 0.06 cfs/acre of development to be discharged to the Gun River.

- Implement low impact development techniques and quantitative storm water design criteria.

- Include innovative storm water management practices in county storm water rules and township land use ordinances.

- Apply conservation, farmland, and open space easements for infiltration and storm water storage areas to reduce the volume and velocity of storm runoff.

- Develop model ordinances or other mechanisms for floodplain management, high risk erosion areas, shoreline setbacks, greenbelts, storm water management, farmland and open space preservation, and wetland protection.

Pollutant/Impairment:

Obstructions

Impairment to Designated Uses:

Obstructions are high level impairments to agriculture, navigation, and partial body contact recreation in the Gun River. Obstructions in the Watershed include log jams, trash, appliances, and a bathtub. Debris in the stream diverts flows, causing streambank erosion and changes to the channel morphology.

Sources:

Organic sources, such as fallen trees and branches, either fall from the streambanks or are washed down during high flows. Trash, appliances, and tires are intentionally dumped in the stream or can also be washed down in high flows.

Causes:

Streambank erosion causes trees to fall in the Gun River. Illegal dumping and lack of enforcement perpetuate the problem of trash in the Gun River.

Goal:

Manage obstructions.

Objectives:

Best Management Practices

- Clear obstructions in areas that are blocking flow and causing flooding on agricultural lands.
- Clear obstructions for navigation and recreation or keep obstructions for habitat where appropriate.

Pollutant/Impairment:

E. coli

Impairment to Designated Uses:

E. coli can cause serious illnesses in humans and animals, and has been a documented problem in Gun Lake. It is a high priority impairment to agriculture and partial and total body contact recreation in Gun Lake. *E. coli* has not been adequately tested for in the Gun River and is therefore a low priority impairment to partial and total body contact recreation. The health risks this bacteria poses necessitates its inclusion in this plan to prevent *E. coli* from becoming a significant problem.

Sources:

E. coli is found in the digestive system of warm-blooded animals and is spread through feces. The detection of *E. coli* often indicates that other dangerous types of bacteria might be present. *E. coli* cannot live for long periods of time outside of a host body, therefore, when found in surface Watershed, the source must be relatively close. Potential sources include livestock in the stream, wildlife, septic systems, and manure storage areas.

Causes:

Unlimited access to streams allows livestock and wildlife to spread bacteria. Leaking, poorly sited and maintained, and undersized septic systems allow *E. coli* to enter waterbodies. Leaching or overflowing manure storage areas and improper land application of manure can also add bacteria to the streams.

Goal:

Prevent *E. coli* from entering surface waters and attain water quality standards for total body contact recreation from May 1 to October 1 in Gun Lake.

Objectives:

Best Management Practices

- Encourage testing and selective monitoring in high risk areas.
- Create volunteer monitoring program.

Land Use Planning

- Develop model ordinances or other mechanisms for shoreline setbacks, green belts, slope protection, storm water management, and wetland protection.

Pollutant/Impairment:

Temperature

Impairment to Designated Uses:

Temperature is considered a high priority impairment to the coldwater fishery and a medium priority impairment to the warmwater fishery. Temperature is significant to coldwater fisheries. Coldwater fish species require water temperatures to remain below a certain temperature during summer months.

Sources:

Surface runoff, especially near parking lots and heavily paved areas, contributes warmwater to streams. Low base flows prolong exposure to summer heat and solar radiation. Lack of streamside vegetation exposes the water to be heated by the sun.

Causes:

Increases in impervious surfaces reduces infiltration, causing increases in temperatures and the water. Excessive irrigation causes low flows which increase temperatures. Destruction of streamside vegetation eliminates shading from the sun.

Goal:

Maintain coldwater fishery.

Objective:

Best Management Practices

- Encourage drain maintenance projects to only remove trees on north and west side of drains to provide shade for stream.

Land Use Planning

- Adopt site design criteria that minimize impervious surfaces, promote infiltration to increase base flow, and maintain riparian corridors, according to low impact development principles.
- Develop model ordinances or other mechanisms for shoreline setbacks, greenbelts, slope protection, storm water management, and wetland protection.

Pollutant/Impairment:

Hydrocarbons and Other Contaminants

Impairment to Designated Uses:

Hydrocarbons and other contaminants are low level impairments to indigenous aquatic life and wildlife. These contaminants affect fish and macroinvertebrate populations and may travel great distances downstream. Petroleum products interrupt the balance of the ecosystem by adding toxins and other substances to the water.

Sources:

Irrigation pumps and other machinery along the banks of the streams and leak fuel and oils.

Causes:

Old, inefficient, leaking, or faulty pumps and machines release petroleum by-products into the Gun River.

Goal:

Reduce potential for hydrocarbon contamination.

Objective:

Best Management Practices

- Improve efficiency and maintenance of irrigation pumps.
- Evaluate the use of electric or solar powered pumps.
- Assess fuel storage facilities through Farm*A*Syst programs.

Land Use Planning

- Improve storm water management to reduce runoff.

Pollutant/Impairment:

Invasive Species

Impairment to Designated Uses:

Invasive species are a medium level priority impairment to indigenous aquatic life and wildlife and are a low priority to agriculture. Invasive species, specifically zebra mussels, purple loosestrife, and Eurasian watermilfoil have been found in Gun Lake. Garlic mustard is a nuisance in riparian forest communities.

Sources:

Invasive species are spread by physical transport, such as on boats and cars, or through environmental sources such as wind, birds, and other animals.

Causes:

Unstable or disturbed areas are more susceptible to invasion than healthy ecosystems. Lack of knowledge about invasive species often spreads them unintentionally.

Goal:

Minimize spread of invasive and exotic species.

Objectives:

Best Management Practices

- Investigate effective techniques to control Eurasian watermilfoil, purple loosestrife, and zebra mussels.

Pollutant/Impairment:

Fragmentation of Habitat

Impairment to Designated Uses:

Fragmentation of habitat is a low level priority to indigenous aquatic life and wildlife. The areas around Gun Lake as well as to the southwest of the Watershed are developing rapidly, taking large tracts of forest and cropland out of the ecosystems. Many species are reliant on large tracts of territory and/or migration corridors. Land use changes downsize these areas and wildlife may be forced onto fringe lands. This can lead to conditions where wildlife take on new niches that may conflict with new land uses. Fringe species may now have access to forest communities that cannot compete, destroying populations.

Sources:

Development of large tracts of land are disrupting continuous area of habitat.

Causes:

Lack of planning for controlled growth causes haphazard development to occur in the Watershed.

Goal:

Minimize habitat fragmentation.

Objectives:

Best Management Practices

- Encourage riparian buffers through proper drain maintenance.

Land Use Planning

- Encourage riparian buffers through buffer ordinances.
- Encourage responsible land use planning through adoption of low impact development techniques and education of local officials.

- Develop model ordinances or other mechanisms for greenbelts, farmland and open space protection, and wetland protection.

- Promote conservation, farmland, and open space easements to protect habitat.

7.2 RECOMMENDATIONS FOR IMPLEMENTATION

7.2.1 BEST MANAGEMENT PRACTICES

The implementation of BMPs are required to address nonpoint sources and improve water quality. Other strategies are community outreach/education and institutional management (land use planning, conservation easements). BMPs address the physical sources of water quality impairments and therefore are an important part of the overall NPS pollution reduction strategy.

The implementation of BMPs requires the coordination of landowners, agencies, organizations, and partners. The Implementation Strategy, Tables 7.3 – 7.10, serves as the guide for determining the location and frequency of practice implementation. The implementation schedules for all BMPs are included for each impairment. Descriptions of the technical assistance, estimated costs, and possible financial assistance are also included in the tables.

Table 7.3 - Agriculture

BMPs	Technical Assistance	Unit Costs	Amount	Total Cost	Financial Assistance	Implementation Schedule		
						High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Conservation Tillage	Conservation District, NRCS 230 hours	$10 ac/yr	1440 ac	$14,400	USDA Great Lakes Basin Program for SESC	$5,600	$7,200	$800
Filter Strips	Conservation District, NRCS 170 hours	$190 ac est.	34.5 ac. (over 10 yrs)	$6,555	USDA Programs, Pheasants Forever	$2,850	$3,135	$570
		$58 ac/yr rental	34.5 ac. (over 10 yrs)	$2,001	USDA Programs, Pheasants Forever	$14,964	$9,570	$1,740
Fence	Conservation District, NRCS 50 hours	$6 yd	500 yd	$3,000	USDA Programs	$3,000	$ -	$ -
Cover crops	Conservation District, NRCS 76 hours	$12 ac	120 ac	$1,440	USDA Great Lakes Basin Program for SESC	$1,440	$ -	$ -
Windbreak	Conservation District, NRCS 53 hours	$240 ac	10.8 ac	$2,592	USDA Great Lakes Basin Program for SESC	$2,592	$ -	$ -
Pollutant: Sediment and nutrients **Sources:** Agricultural operations **Causes:** Conventional tillage, plowing too close to stream, unlimited livestock access, lack of cover crops, lack of streamside vegetation				**$29,988**	**TOTAL**	**$30,446**	**$19,905**	**$3,110**

Table 7.4 - Rill and Gully Erosion

BMP	Technical Assistance	Unit Costs	Amount Each	Task	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Berm and Tube with Vegetated Geogrid	Conservation Districts USDA 380 hours	$1,500 each	10 each	Berm	$21,833	USDA Programs	$13,656	$6,607	$1,571
		$20 sq. yd	342 sq. yd	Geogrid					
Branch Packing	Conservation Districts USDA 15 hours	$25 foot	32 feet	Pack	$800	USDA Programs	$500	$300	$0
Rock Chute	Conservation Districts USDA 20 hours	$10 sq. yd	113 sq. yd	Rock	$2,143	USDA Programs	$1,742	$401	$0
		$2 sq. yd	113 sq. yd	Grading					
Grassed Waterway	Conservation Districts USDA 252 hours	$2,245 acre	12 acres	Establishment	$26,940	USDA Programs	$4,490	$8,980	$13,470
Pollutant: Sediment **Sources:** Rills and gullies **Causes:** Conventional tillage, plowing up and down slope, lack of streamside vegetation					**$51,716**	**TOTAL**	**$20,387**	**$16,288**	**$15,041**

Table 7.5 - Road/Stream Crossings

BMPs	Technical Assistance	Unit Costs	Amount	Total Cost	Financial Assistance	Implementation Schedule		
						High Priority 0 to 5 years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Replace Culvert	Road Commission 190 hours	$382 foot	5 sites	$48,514	Road Commission	$30,178	$18,336	-
Riprap	Road Commission 30 hours	$75 sq. yard	3 sites	$1,950	Road Commission	$900	$600	$450
Repair Culvert/Bridge	Road Commission 40 hours	$1,125 foot	1 sites	$28,125	Road Commission	$28,125	$0	-
Bioengineering/Riprap	Road Commission, Conservation Districts, Drain Commissioner 40 hours	$4 foot $75 sq. yard	4 sites	$3,168	Road Commission	$1,584	$1,584	-
Bioengineering	Road Commission, Conservation Districts, Drain Commissioner 190 hours	$4 foot	19 sites	$3,960	Road Commission	$1,944	$1,152	$864
Monitor and maintenance	Road Commission, Conservation Districts, Drain Commissioner 80 hours	$201 each	10 sites	$2,010	Road Commission	-	-	$2,010
Pollutant: Sediment				**$87,727**	**TOTAL**	**62,731**	**21,672**	**3,324**

Sources: Road/stream crossings

Causes: Degraded bridges and culverts, culverts too short, steep side slopes, undersized culverts, lack of maintenance

Table 7.6 - Streambank Erosion

BMPs	Technical Assistance	Unit Costs	Task	Amount	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 years	Low Priority 10 to 20 Years
Bioengineering or tree revetment w/riprap	Conservation District Drain Commissioner NRCS 310 hours	$4 foot	Bioengineering	31 sites	$210,930	NOAA Community-Based Restoration Program (April, 18 mos., 1:1 match) Trout Unlimited	$187,230	$23,700	-
		$75 yard	Riprap						
Backfill and drain w/bioengineering	Conservation District Drain Commissioner NRCS 40 hours	$18 cubic yard	Excavation	4 sites	$12,850	Drainage Districts	$12,850	-	-
		$4 foot	Bioengineering						
		$75 sq. yd	Riprap						
Riprap	Conservation District Drain Commissioner NRCS 10 hours	$75 sq. yd	Riprap	1 site	$750	Drainage Districts	$750	-	-
Bioengineering	Trout Unlimited Michigan DNR 120 hours	$4 foot	Bioengineering	12 sites	$3,000	NOAA/Trout Unlimited Partnerships	$800	$2,120	$80
Obstruction Removal and Bank Repair	Trout Unlimited Michigan DNR 20 hours	$325 hour	Labor	2 site	$3,740	NOAA/Trout Unlimited Partnerships	$3,740	-	-
		$4 foot	Bioengineering						
		$75 sq. yd	Riprap						
Bank Shaping	Conservation District Drain Commissioner NRCS 138 hours	$6 cubic yard	Excavation	3 site	$33,173	NOAA/Trout Unlimited Partnerships	-	$33,173	-
		$4 foot	Bioengineering						
		$75 sq. yd	Riprap						
Pollutant: Sediment					**$264,443**	**TOTAL**	**$205,370**	**$58,993**	**$80**
Sources: Streambank erosion									
Causes: High flows, obstructions, lack of streamside vegetation									

Table 7.7 - Tile Outlets

BMPs	Technical Assistance	Unit Costs	Task	Amount	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Check Inlet / Stabilize	Conservation District NRCS	$75 sq. yard	Riprap	3 sites	$4,950	USDA Programs	$2,700	$2,250	-
	114 hours	$150 hour	Labor						
Extend Outlet	Conservation District NRCS	$30 foot	extension	1 site	$780	USDA Programs	-	$780	-
	38 hours	$150 hour	Labor						
Maintenance	Conservation District NRCS	$60 year	Labor	14 sites	$840	USDA Programs	-	-	$840
	280 housr								
Outlet Stabilization	Conservation District NRCS	$75 sq. yard	Riprap	10 sites	$20,625	USDA Programs	$8,175	$9,750	$2,700
	380 hours	$150 hour	Labor						
Replace Pipe / Repair Bank	Conservation District NRCS	$30 foot	repair	3 sites	$5,940	USDA Programs	$5,940	-	-
	114 hours	$75 sq. yard	Riprap						
		$150 hour	Labor						
Riprap	Conservation District NRCS	$1,388 each	Riprap	1 sites	$750	USDA Programs	-	$750	-
	38 hours								
Pollutant: Sediment					**$33,885**	**TOTAL**	**$16,815**	**$13,530**	**$3,540**

Sources: Tile outlets
Causes: Improperly installed tile, high flows, tile too short, outlet not maintained

Table 7.8 - Trash and Debris

BMPs	Technical Assistance	Unit Costs	Task	Amount	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Obstruction removal - dam	Drain commissioner Landowner Trout unlimited 38 hours	$150 hour	Labor and Heavy equipment	1 site	$1,200	Trout Unlimited MDNR	$1,200	-	-
Obstruction removal - extensive	Drain commissioner NRCS 80 hours	$4 foot	Labor and heavy equipment	4 site	$2,800	Drainage Districts	$2,000	$800	-
Obstruction removal - ext., volunteer clean-up	Conservation district Townships Drain commissioner JTPA 20 hours	$60 day	Labor and heavy equipment	2 site	$920	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	$920	-	-
Obstruction removal - mod.	Conservation district Drain commissioner Friends of the Gun River Townships 80 hours	$4 foot	Labor and heavy equipment	8 site	$1,600	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	$1,200	$400	-
Obstruction removal - slight	Conservation district Friends of the Gun River JTPA AISD Townships 50 hours	$4 foot	Labor and heavy equipment	5 site	$200	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	$40	$120	$40

Table 7.8 - Trash and Debris

BMPs	Technical Assistance	Unit Costs	Task	Amount	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Obstruction removal - slight, volunteer clean-up	Conservation district Friends of the Gun River AISD Townships 20 hours	$4 foot $60 day	Labor and heavy equipment Management	2 site	$200	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	-	$200	-
Volunteer clean-up, 1 day	Conservation district Friends of the Gun River AISD Townships 90 hours	$60 day	Management	9 site	$540	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	$60	$300	$180
Volunteer clean-up, 2 days	Conservation district Friends of the Gun River AISD Townships 20 hours	$60 day	Management	2 site	$240	Volunteer Clean-up Grant (June, 4 months, 25% match) www.michigan.gov/deq/water/surfacewater/nps/grants	-	$240	-
Pollutant: Sediment, heavy metals, hydrocarbons, petroleum by-products					**$7,700**	**TOTAL**	**$5,420**	**$2,060**	**$220**

Sources: Trash and debris
Causes: Obstructions, illegal dumping, lack of stewardship

Table 7.9 - Construction

BMP	Technical Assistance	Unit Costs	Task	Amount Each	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 Years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Soil Erosion and Sediment Control	MTS, Townships, and Drain Commissioner	$500 acre	Mulch	2.0 acres	$1,525	Townships	$1,525	-	-
	20 hours	$2 foot	Silt Fence	300.0 feet					
Pollutant: Various					**$1,525**	**TOTAL**	**$1,525**	**-**	**-**

Sources: Construction

Causes: Upland agricultural practices, degraded road crossings, altered hydrology, illegal dumping, obstructions, lack of SESC

Table 7.10 - Other

BMP	Technical Assistance	Unit Costs	Task	Amount Each	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Filter strip	Conservation districts, NRCS 15 hours	$190 acre	Establishment	3.0 acres	$1,884	USDA programs	$1,256	$628	-
		$58 acre	Lease	3.0 acres					
Turf management	MSU Extension N/A hours	$175 plot	Nutrient budgeting	10.0 Plots	$1,750	USDA programs	$1,750	-	-
Filter strip and crossings	Conservation districts, NRCS, drain commissioners 65 hours	$190 acre	Establishment	3.0 acres	$1,770	USDA programs	$1,770	-	-
		$58 acre	Lease	3.0 acres					
		$1,200 each	Crossing	1.0 each					
Check for septic failure, turf management BMPs, roadside filter strips	County health depts. MSU extension N/A hours	$78-2530 acre	Various	1.0 site	$1,910	HB 4625 - sewer infrastructure improvements	$1,910	-	-
Invasive species	Gun Lake Association N/A hours	Unknown	Research	Gun Lake	unknown	Michigan Great Lakes Protection Fund (due April, 1-3 years, no match required) MDNR Michigan Lakes and Streams Association (in-kind services)	-	$25,000	-

Table 7.10 - Other

BMP	Technical Assistance	Unit Costs	Task	Amount Each	Total Cost	Financial Assistance	Implementation Schedule		
							High Priority 0 to 5 years	Medium Priority 5 to 10 Years	Low Priority 10 to 20 Years
Solar irrigation pump	Conservation districts MSU Extension 10 hours	$3,800 each	Research and installation	1.0 pump	$3,800	The Charles A. and Anne Morrow Lindbergh Foundation (June, 1 year, no match required) www.lindberghfoundation.org	-	$10,580	-
Monitor and maintain	Conservation districts MSU Extension 20 hours	$60 year	Various	2.0 sites	$120	N/A	-	-	$120
Wetland restoration	U.S. Fish and Wildlife Service 75 hours	$2,530 acre	Restoration	0.5 acres	$1,265	North American Wetlands Conservation Fund (December, 2 years, 1:1 match) http://birdhabitat.fws.gov/NAWCA/grants.htm	$1,265	-	-
Pollutant: Various					**$12,499**	**TOTAL**	**$7,951**	**$36,208**	**$120**

Sources: Various
Causes: Various
Note: Hours based on actual 2-year implementation project, does not include time for engineering or permit review. Hours not included in total cost of the project. Hours will vary from those shown due to specific site factors.

7.2.2 LAND USE PLANNING

Institutional management steps to improve water quality range from the adoption of conservation easements and farmland preservation to the development of model ordinances that recognize additional requirements in sensitive areas (setbacks, slope protection) and low impact development techniques such as reducing impervious surfaces to increase infiltration. These tools allow for long-term preventive measures that account for changes in land use. BMPs can be installed, but when the land use changes, that BMP may no longer address the problem or may be removed. Institutional management can bridge the gap between needing to address physical sources impacting water quality BMPs and a community's desire to meet future land use needs.

Currently, no townships in the Watershed have a comprehensive ordinance designed to protect water quality. Township ordinances have the greatest potential for future protection of resources in the Watershed. Open areas, including forest, wetlands, and farmlands, are essential for stable hydrology, wildlife habitat, and the reduction of inputs of pollutants.

Watershed communities can view institutional management strategies as a palette of choices to paint the picture that best fits local desires and needs. The process to review the status of key watershed communities will be part of the education/outreach strategy to raise awareness of water quality issues and gain consensus for the solutions. The WMP and H&H study will be used as a basis for land use planning tools to adopt measures that protect water quality. These tools will consist of these elements:

- Overlay maps on a township scale based on existing information that provide overlay districts highlighting sensitive areas (as defined by the township for water quality) that will assist planners with land use decisions and site considerations (setbacks, slope protection).

- Improved storm water management techniques through ordinances or site design criteria that minimize impervious surfaces, reduce runoff, promote infiltration to increase base flow, and maintain riparian corridors, according to low impact development principles.

- Encourage storm water detention policy that allows no more than 0.06 cfs/acre of development to be discharged to the Gun River.

- Model ordinances for water quality protection (floodplain management, high risk erosion area protection, setbacks, green belts, wetland protection, and storm water management, for example.)

- Conservation easements, open space, farmland protection to protect high quality areas, preserve rural character, and provide areas for infiltration and storage (open space and wetlands).

- Implementation of Low Impact Development techniques. Storm water infiltration areas instead of detention, rain gardens, impervious surface reduction through site design and filter strips, vegetation buffers along waterbodies (lakes, streams, rivers, and drains.)

- An examination of wildlife management strategies near surface water.

- Septic systems inspections.

- Integration of maps of flood prone areas with Allegan County LIS to regulate development.

- Use of Hydrologic analysis to expedite regular participation in the FEMA Flood Insurance Program.

Education programs are also needed to increase stewardship and awareness of for those living in the Watershed. Providing regulations and ordinances for development is much more effective if the public has an understanding of why these guidelines exist. A detailed explanation of information and educational strategies are outlined in Chapter 6.

7.3 OTHER RECOMMENDATIONS

7.3.1 NPDES PHASE II

Sediment has been identified as the major pollutant in the Watershed. Focusing on sedimentation BMPs can have the desired outcome for restoring stream habitat as well as meeting TMDL goals for phosphorus reduction in the Kalamazoo River and to remove Gun Lake from the 303(d) list. Public Act 451, Part 91, established local SESC measures. As of March 10, 2002, a Part 91 (SESC) permit is required during construction or earthmoving activities for all sites of 1 acre or more or within 500 feet of a water body. Public Act 451, Part 31, stated the regulations for the Phase II of the National Pollutant Discharge Elimination System (NPDES). Phase II regulations require sites of 1 acre or greater, with a potential for discharging to a water of the state, to have a storm water operator and daily logs of the operation, but no NPDES permit is required. All sites of 5 acres or more are required to have both an SESC permit and an NPDES permit and to follow the other provisions in the Permit by Rule. The enforcement of these rules by the appointed county enforcing agency is imperative in the lakefront and southern regions of the watershed, where development is occurring rapidly.

7.3.2 WETLAND RESTORATION

The determination of wetland restoration sites depends considerably on the presence of hydric soils. Areas where hydric soils are present were historically wet, and the soils are more likely to have suitable chemical and physical properties for wetlands than upland soils. Where wetlands have been eliminated by artificial drainage, restoration may be as simple as plugging a ditch or breaking a tile that drains the wetland area. Studies have shown that wetlands constructed in historically upland areas are not as successful and do not have the functional capacity of restored wetlands, therefore, hydric soils should be sought. The most amenable areas are usually agricultural fields that remain wet during the spring planting season or frequently flood during the growing season. Other idle fields or pasture areas are also good possibilities.

Programs are available to landowners wishing to restore wetlands on their property. The most common programs for agricultural land are the Wetland Reserve Program (WRP) and the Conservation Reserve Program (CRP). Each of these programs provides technical assistance and other resources toward wetland restoration. Varying amounts of soil rental rates are paid to the landowner in each of these programs for taking their land out of production. The programs are implemented on a site-by-site basis and administered by the USDA NRCS and/or the FSA.

The Michigan Wildlife Conservancy and United States Fish and Wildlife Service (USFWS) are also active in restoring wetlands for wildlife throughout the state. Generally, the landowner bears no cost and the land does not have to be in agriculture to be eligible.

Wetlands do not have to be historically located in an area to have land use benefits. Constructed wetlands can be used to filter water from urban runoff, storm sewers, or combined sewer overflows. Wetland plants extract excess nutrients and heavy metals out of the water, and though it is not always necessary, harvesting these plants, especially in more polluted waters, can be a way to remove the nutrients and metals from the system. Two well known success stories of this process are the Tollgate Wetlands in Lansing and the Inkster Wetlands near Detroit.

Wetland mitigation may be an option. The MDEQ may issue a permit in special circumstances to allow a wetland to be destroyed under the stipulation that for every acre of wetland destroyed, two acres of wetland must be constructed or restored. The new wetlands are called mitigated wetlands, and contractors normally pay landowners well for the construction of these wetlands. Mitigated wetlands may also be banked. These wetlands are constructed or restored in advance of losses through the MDEQ regulatory program and sold or used as needed.

7.4 ANTICIPATED POLLUTION REDUCTIONS

The estimated load reductions for sediment and nutrients have been determined using the best available information. The load reductions are estimated for agricultural sources and NPS sites that were previously described in Chapter 4. The BMPs selected to address those sources and sites were determined to be the most feasible and cost effective for this Watershed.

Sediment and Nutrient Loadings and Reductions

The systems of BMPs that have been identified to be implemented in the Watershed to achieve the estimated load reductions were determined from the information collected during the Watershed inventory and previous studies. Certain assumption had to be made to use the Michigan State University's *"Revised Universal Soil Loss Equation (RUSLE) Online Soil* Erosion *Assessment Tool"* and the MDEQ's *Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual* to estimate the sediment and nutrient loading and reductions in the Watershed. All of the calculations were computed at the sub-district levels that were delineated for the Hydrological and Hydraulic Analysis (Figure 3). The following assumptions and methodologies were used:

- The contributing area of the agricultural land was estimated within each sub-district using land use maps.

- Soil types within each sub-district were evaluated separately and the results were weighted to obtain a single soil loss value for each sub-district.

- The major soil types of the those agricultural areas were categorized using the USDA Soil Survey of Allegan County and Barry County. Each soil type has an associated range of slopes. The median of each range was used for each soil type.

- The "Before Treatment" (existing) crop rotation and tillage conditions were assumed, based on certain soil types, rotations, and tillage practices, as described in Appendix 3.

- The "After Treatment" (after BMP implementation) crop rotation and tillage conditions were assumed based on the soil types and rotations, as described in Appendix 3, and the conservation tillage practices recommended in this WMP (Tables 7.3 – 7.10).

- Areas of conservation tillage and filter strips were obtained from Tables 7.3 through 7.10.

- A weighted average, based on the areas of conservation tillage and filter strips, was used to determine the soil loss “After Treatment.”

The complete methodology and associated assumptions are described in Appendix 3. The inventory conducted in the Watershed during the planning phase collected sufficient information to calculate the pollutants reduced at the sites, rather than relying on estimates of pollutant removals from other studies. These calculations enabled the evaluation of the specific recommendations in the WMP and prioritization of the remediation efforts on a sub-district level.

Table 7.11 provides a summary of the calculations of the estimates of sediment and nutrient loadings and reductions in the sub-districts of the Watershed. The numbers, themselves, do not give a completely accurate representation of the tons of sediment or pounds of nutrients delivered to the stream, but rather can be used to prioritize the sub-districts by their relative loadings to the Gun River, since the assumptions and methodologies were consistently applied to all the sub-districts.

Table 7.11 - Overall Sediment and Nutrient Reduction

Sub District	Before Sediment Delivery (tons/yr)	After Sediment Delivery (tons/yr)	Total Sediment Reduction (tons/yr)	Before Phosphorous Content (lbs/yr)	Before Nitrogen Content (lbs/yr)	After Phosphorous Content (lbs/yr)	After Nitrogen Content (lbs/yr)	Total Phosphorous Reduction (lbs/yr)	Total Nitrogen Reduction (lbs/yr)
Gregg's Brook	2234	2117	117	5896	11828	5622	11297	273	531
Orangeville Drain	4680	4586	94	7383	14767	7266	14545	116	222
Fenner Creek	2470	2419	51	4135	8242	4059	8101	77	140
Reno Drain	1163	1151	12	2913	5813	2895	5776	18	37
Culver Drain	4695	4181	515	6618	13258	5938	11966	681	1292
Sutherland Drain	1440	1246	194	3595	7178	3135	6349	460	830
Monteith Drain	1763	1755	8	3109	6218	3099	6198	10	20
Along US-131	506	506	0	947	1894	947	1894	0	0
Bellingham Drain	1032	834	198	2563	5115	2114	4294	449	821
Otsego Plainwell	790	762	28	1503	3007	1458	2921	46	86
Scott Whitcomb	1076	1046	30	2777	5569	2713	5448	64	122
Gun River Corridor	46	0	46	69	138	0	0	69	138
Total	21848	20602	1246	41440	82891	39246	78790	2194	4101

- This Table summarizes the Overall or "**Total**" (Agricultural Fields and NPS Pollution Sites) Sediment and Nutrient Reductions.
- **Before Sediment Delivery** = Existing Sediment Loading, Before any BMPs have been implemented.
- **After Sediment Delivery** = Sediment Loading, After BMPs have been implemented.
- **Total Sediment Reduction** = Reduction in Sediment Loading as a result of BMP Implementation. **Delivery Ratio** was Factored into Agricultural Fields portion of Total Sediment Reduction.
- **Before Phosphorous Content** = Existing Phosphorous Loading, Before any BMPs have been implemented.
- **Before Nitrogen Content** = Existing Nitrogen Loading, Before any BMPs have been implemented.
- **After Phosphorous Content** = Phosphorous Loading, After BMPs have been implemented.
- **After Nitrogen Content** = Nitrogen Loading, After BMPs have been implemented.
- **Total Phosphorous Reduction** = Reduction in Phosphorous Loading as a result of BMP implementation.
- **Total Nitrogen Reduction** = Reduction in Nitrogen Loading as a result of BMP implementation.

Pollutant reductions for phosphorus and nitrogen are based on the amount of sediment delivered, thus the calculations are dependent on the accuracy of the data collected at the site pertaining to soil loss. These were rough field measurements, following suggested ranges of measurements to tally on the data collection sheets. The results, therefore, are purely estimates of the pollutant removal capability of the BMPs installed. Site specific measurements and calculations would yield much more realistic numbers. The estimates were calculated for recommended agricultural practices and other NPS sites in the Watershed.

The implementation of the land use planning initiative are expected to result in no net increase of pollutants to the Gun River.

As stated in Chapter 4, the Kalamazoo River/Lake Allegan TMDL study reported the seasonal nonpoint source phosphorus loading predictions for the Gun River Watershed as 6,117 lbs/season and the annual loading prediction as 11,119 lbs/year. The estimated phosphorus loading calculated in this WMP was 41,440 lbs/yr. This discrepancy could be a result of the numerous sinks where phosphorus could be held and not entering the Gun River. The TMDL for the Kalamazoo River/Lake Allegan set a goal of reducing the phosphorus loading by 37.5% for the entire area. Using that goal as a baseline for the Gun River Watershed, phosphorous loading reduction goals should be 15,540 lbs/yr. The calculations, however, for the phosphorus reductions in the Watershed from implementing all of the recommended BMPs result in only 2,194 lbs/year. These calculations were based on a number of variables and assumptions that differ from the model for the TMDL study, thus predictions are bound to vary. The assumptions and methodology of the reduction calculations can be review in Appendix 3.

Many combinations of BMPs, including agricultural, urban, structural and managerial, can be implemented to realize pollutant reduction goals. The most effective combination will be the one that is most feasible for the stakeholders based on cost, acceptability and sustainability. Local, national, and global efforts are continuing to identify pollutant removal effectiveness of BMPs and estimated pollutant reductions expected from implementing BMPs. Not all of the answers to the question of which practices will meet the pollutant reduction goals are included in this WMP due to lack of data for the practices and site-specific conditions. However, best available information has been referenced to estimate phosphorus reduction predictions in the interest of determining a path to pollutant reductions appropriate to the Watershed.

7.5 DESIRED USES

The desired uses for the Watershed will need to be evaluated individually to assess the compatibility of the desired use to the overall goals of the Watershed. Table 7.12 identifies the potential partners and

funding opportunities that could assist in the realization of the desired uses, should the Steering Committee agree to pursue them.

Table 7.12 - Partners and Funding for Desired Uses

Desired Uses	Potential Partners	Funding Opportunities
Groundwater protection for drinking water	Health Departments County Wellhead Protection Program County LIS Department MSU Extension	Michigan Groundwater Stewardship Program
Increased recreation opportunities	MDNR Kalamazoo Downstreamers County Drain Commissioners Riparian residents Trout Unlimited	MDNR Recreational Grants Trout Unlimited
Preserved open space and rural character	Southwest Michigan Land Conservancy Watershed residents Township officials The Nature Conservancy	Southwest Michigan Land Conservancy USDA CRP
Federal or state protection of the Gun River	MDNR US EPA Riparian residents	
Gun River Trailway	Kalamazoo River Valley Trailway group Riparian residents Local schools Sauk Trails RC&D	MDNR Recreational Grants
Protected prime farmlands	USDA NRCS, FSA Conservation Districts Farmers MDA Township officials	Michigan Farmland Trust USDA NRCS CRP PA 116
Protected unique habitats for endangered species	Watershed residents MDNR Natural Heritage Program Township officials	Southwest Michigan Land Conservancy
Restored wildlife habitats	Michigan Wildlife Conservancy County Drain Commissioners Township officials Pheasants Forever	Michigan Wildlife Conservancy

CHAPTER 8 - EVALUATION METHODS

8.0 EVALUATION CRITERIA AND MONITORING

An evaluation of the implementation of the Watershed Management Plan (WMP) will provide the Steering Committee an opportunity to assess the effectiveness of the activities that have been implemented to achieve the goals set forth in the WMP. Interim, measurable milestones were described for each Best Management Practice (BMP) and land use planning initiative recommended in Chapter 7. This chapter will describe the set of criteria, based on the milestones developed, that will be used to determine if the pollutant reductions are being achieved over time and if substantial progress is being made toward attaining water quality standards. Criteria will also be established to determine whether the WMP needs to be revised if the pollution reductions are not being achieved or progress is not being made toward attaining water quality standards. A monitoring component is also described to evaluate the effectiveness of the implementation efforts over time, based on the criteria.

The evaluation criteria provides an indication of how BMPs and land use planning initiatives can be measured to evaluate success. Some criteria are more appropriate for measuring progress on a watershed basis, such as a public awareness surveys and fishery surveys. Other criteria are more appropriate for specific sites or small tributaries, such as pollutant reduction calculations or student monitoring results. Through this evaluation process, communities and agencies will be better informed about public response and success of the project, what improvements are necessary to the project, and which BMPs and land use planning initiatives to continue as part of the project. The success of the BMPs and land use planning initiatives, collectively and over time, is assumed to have a positive impact on the water quality, even though these evaluation criteria are not directly tied to water quality measurements.

8.0.1 BEST MANAGEMENT PRACTICES

Sediment

Milestones for achieving the goal of reducing soil erosion and sedimentation were based on the implementation of BMPs with the following objectives:

Objective:

- Use more preventative measures rather than remediation efforts.
    - Milestones:

- Exclude livestock from all waterways within 5 years
- Install 90% of berm and tube structures within 10 years
- Install all branch packing structures within 10 years
- Install all rock chute structures within 10 years
- Install 50% of grassed waterways within 10 years
- Complete all check inlet and stabilization structures within 10 years
- Stabilize 90% of the outlets within 10 years
- Complete extended outlet within 10 years
- Conduct monitoring and maintenance on all sites within 20 years
- Maintain all sites within 20 years

Objective:

- Increase use and quality of filter strips and windbreaks.
  - Milestones:
    - Install 90% of filter strips and crossings within 5 years.
    - Install all windbreaks within 5 years.
    - Install all filter strips within 10 years.

Objective:

- Encourage farmers to use cover crops and promote no-till farming.
  - Milestones:
    - Implement all cover crop practices within 5 years.
    - Implement 90% of conservation tillage practices within 5 years.

Objective:

- Review SESC inspections and enforcement procedures.
  - Milestones:
    - Increase effectiveness of inspections within 10 years.
    - Promote attendance of road commission and drain commissioner's employees at yearly MDEQ SESC training sessions.

Criteria:

- Increase in time between dredging of Gun River and its tributaries.
- Increase in Water Quality Rating in MDEQ biological surveys.
- Number of BMPs implemented to reduce sediment.
- Comparison of before and after photographs of BMPs installed to reduce sediment.

Monitoring:

- Review of drain commissioner's maintenance schedules.
- MDEQ biological surveys.
- USDA yearly status reviews.
- Allegan Conservation District's annual report on the Gun River Watershed.
- Pollutant reduction calculations.
- Cost/benefit comparison of BMPs and pollutants reduced

Nutrients

Milestones for achieving the goals of reducing phosphorus loading and establishing TMDLs in designated areas were based on the implementation of BMPs with the following objectives:

Objectives

- Use systems approach on farms with conservation planning and comprehensive nutrient management plans.
    - Milestones:
        - 50% agricultural producers participate in the progressive planning process in 5 years.
        - 75% agricultural producers complete progressive planning (site review and two plans) in 10 years.
        - 100% agricultural producers completed the progressive planning process and/or have a CNMP developed in 15 years.

Objectives:

- Increase technical support and funding opportunities for implementing agricultural conservation programs.
    - Milestones:
        - Increase landowners participation in agricultural programs by 10% within 5 years.

Objectives:

- Educate homeowners and lawn care companies to use less fertilizers on lawns.
    - Milestones:
        - Distribute educational materials to all sites within 5 years.
        - Provide education about turf management within 5 years.

Objectives:

- Address residential septic systems.
    - Milestones:
        - Identify failing systems through inspections within 5 years.

Objectives:

- Educate homeowners about composting to reduce dumping of yard waste into streams.
    - Milestones:
        - Initiate volunteer clean-ups to remove trash and debris within 5 years.

Criteria:

- Increase in Water Quality Rating in MDEQ biological surveys.
- Number of BMPs implemented to reduce nutrients.
- Increase in number of volunteers for cleanups.
- Comparison of before and after photographs of BMPs installed to reduce nutrients.

Monitoring:

- MDEQ biological surveys.
- USDA yearly status reviews.

- Allegan Conservation District's annual report on the Gun River Watershed.
- Evaluations of volunteer cleanup days.
- Pollutant reduction calculations.
- Cost/benefit comparison of BMPs and pollutants reduced.
- County health departments' annual reports.

Hydrology

Milestones for achieving the goal of stabilizing stream flows to moderate hydrology and increasing base flows were based on the implementation of best management practices with the following objectives:

Objective:

- Use peak flow rates and water surface elevations from hydrologic analysis as basis for in-stream modification.
    - Milestones:
        - Implement 90% of bioengineering improvements by within 5 years.
        - Remove all obstructions within 5 years.
        - Replace pipes and repairs banks within 5 years.
        - Implement 80% of bioengineering improvements within 10 years.
        - Install 80% of specified riprap within 10 years.
        - Complete bank shaping within 10 years.
        - Repair culverts and bridges within 10 years.
        - Install all bioengineering and riprap within 20 years.
        - Implement all bioengineering improvements within 20 years.

Criteria:

Reduction of peak flow rates shown on hydrographs

Monitoring

- Hydrologic Analysis
- Allegan Conservation District's annual report on the Gun River Watershed

Obstructions

Milestones for achieving the goal of managing obstructions were based on the implementation of BMPs with the following objectives:

Objective:

- Clear obstruction in areas that are blocking flow and causing flooding on agricultural lands.
    - Milestones:
        - Remove 75% of specified obstructions within 5 years
        - Remove all specified obstructions within 10 years
        - Replace all specified culverts within 20 years

Objective:

- Clear obstruction for navigation and recreation or keep obstructions for habitat where appropriate.
    - Milestones:
        - Remove all obstructions for navigation within 5 years

Criteria:

- Comparison of before and after photographs of obstructions.

Monitoring

- Stream inventory.
- Allegan Conservation District's annual report on the Gun River Watershed.

E. coli

Milestones for achieving the goal of preventing *E. coli* from entering surface waters and meeting water quality standards were based on the implementation of best management practices with the following objectives:

Objective:

- Encourage testing and selective monitoring for *E. coli* in high risk areas.
    - Milestones:
        - Initiate sustainable monitoring program for high risk areas within 5 years.

Objective:

- Create volunteer monitoring program.
    - Milestones:
        - Initiate sustainable volunteer monitoring program within 5 years.

Criteria:

- Water Quality Standards being met for partial body contact recreation (1,000 counts/ 100ml) in all waterbodies.
- Water Quality Standards being met for total body contact recreation (130 count/100 ml) in Gun Lake.

Monitoring:

- Water quality monitoring for *E. coli*
- Allegan Conservation District's annual report on the Gun River Watershed

Temperature

Milestones for achieving the goal of maintaining a coldwater fishery were based on the implementation of BMPs with the following objectives:

Objective

- Encourage drain maintenance projects to remove trees on only the north and west sides of drain to provide shade for stream.
    - Milestones:
        - Riparian corridors intact on 50% of drain projects.

Criteria:

- Observed recommended tree removal strategy on drains.
- Maintenance of coldwater temperatures.
- Increase of coldwater species of fish.
- Increase in Water Quality Rating in MDEQ biological surveys.

Monitoring:

- Annual drain inspections.
- MDEQ biological surveys
- Allegan Conservation District's annual report on the Gun River Watershed.

Hydrocarbons and Other Contaminants

Milestones for achieving the goal of reducing the potential for hydrocarbon contamination were based on the implementation of BMPs with the following objectives:

Objective:

- Improve efficiency and maintenance on irrigation pumps.
    - Milestones:
        - Improve pumps within 10 years.

Objective:

- Evaluate the use of electric or solar powered pumps.
    - Milestones:
        - Installation of 10 solar powered pumps within 10 years.

Objective:

- Assess fuel storage facilities through Farm*A*Syst program.
    - Milestones:
        - Conduct 20 Farm*A*Syst surveys within 5 years.

Criteria:

- Number of higher efficiency pumps installed or old pumps repaired.
- Number of solar powered pumps installed.
- Number of Farm*A*Syst surveys conducted.

Monitoring:

- Annual drain inspections.
- Allegan Conservation District's annual report on the Gun River Watershed.

Invasive and Exotic Species

Milestones for achieving the goal of minimizing the spread of invasive and exotic species were based on the implementation of BMPs with the following objectives:

Objective:

- Investigate effective techniques to control Eurasian watermilfoil, purple loosestrife, and zebra mussels.
    - Milestones:
        - Propose strategy to control invasive species on Gun Lake within 10 years.

Criteria:

- Decreased observations of invasive species.

Monitoring:

- Natural features inventory on Gun Lake.
- MDEQ biological surveys.
- Allegan Conservation District's annual report on the Gun River Watershed.

Habitat Fragmentation

Milestones for achieving the goal of minimizing habitat fragmentation were based on the implementation of BMPs with the following objectives:

Objective:

- Encourage riparian buffers through proper drain maintenance.
    - Milestones:
        - Riparian buffers maintained on county drains within 10 years.

Criteria:

- Observed recommended tree removal strategy on drains.
- Increase in acres of continuous habitat.

Monitoring:

- Annual drain inspections.
- Land use and cover analysis.
- Allegan Conservation District's annual report on the Gun River Watershed.

8.0.2 LAND USE PLANNING INITIATIVES

Sediment

Milestones for achieving the goal of reducing soil erosion and sedimentation were based on the implementation of land use planning initiatives with the following objectives:

Objective:

- Encourage farmers to request and implement Highly Erodible Land (HEL) conservation plans through the Natural Resources Conservation Service.
    - Milestones:
        - Develop HEL plans with 5 landowners within 5 years.

Objective:

- Apply open space and conservation easements to areas with high erosion potential, not suitable for other land uses, to protect vulnerable slopes.
    - Milestones:
        - Identify areas where conservation easements could be applied in the watershed within 5 years.
        - Secure open space and conservation easements in 25% of identified areas within 10 years.

Objective:

- Develop overlay maps that show areas with high potential storm water runoff where construction techniques that allow more infiltration of storm water to reduce high discharge runoff and the resulting erosion should be applied.
    - Milestones:
        - Develop overlay maps within 5 years.

Criteria:

- Number of HEL conservation plans.
- Number of conservation easements.
- Use of overlay maps in local planning.

Monitoring:

- USDA yearly progress reports.
- Land Conservancy annual report.
- Allegan Conservation District's annual report on the Gun River Watershed.

Nutrients

Milestones for achieving the goals of reducing phosphorus loading and establishing TMDLs in designated areas were based on the implementation of land use planning initiatives with the following objectives:

Objective:

- Examine wildlife management strategies near surface waters.

- Milestones:
  - Identify gaps or inconsistencies of wildlife strategies near surface waters within 5 years.

Objective:

- Implement low impact development strategies that include promotion of low impact landscaping in residential areas (plants that do not require fertilizer).
  - Milestones:
    - Develop low impact development strategies, based on *"Landscaping for Water Quality,"* within 5 years.

Objective:

- Develop overlay maps that show where shoreline (streambank, lakeshore, drain easement) areas are located to reduce use of phosphorus fertilizer.
  - Milestones:
    - Develop overlay maps within 5 years.

Objective:

- Conduct septic system inspections.
  - Milestones:
    - Develop septic system inspection schedule, in cooperation with the Allegan County Health Department, within 5 years.

Criteria:

- Recommendations of wildlife strategies.
- Increased use of low impact residential landscaping.
- Use of overlay maps in local planning.
- Identification of failing or faulty septic systems.

Monitoring:

- MDNR annual report.
- Landscaping company surveys.
- Allegan Conservation District's annual report on the Gun River Watershed.
- Health department annual reports.

Hydrology

Milestones for achieving the goal of stabilizing stream flows to moderate hydrology and increasing base flows were based on the implementation of land use planning initiatives with the following objectives:

Objective:

- Integrate map of floodprone areas with Allegan County LIS to regulate development within floodplain.
    - Milestones:
        - Work with Allegan County LIS to create floodplain map within 5 years.

Objective:

- Use hydrologic analysis to expedite regular participation in the FEMA Flood Insurance Program.
    - Milestones:
        - Enroll two townships in the FEMA Flood Insurance Program within 5 years.

Objective:

- Encourage storm water detention policy that allows no more than 0.06 cfs/acre of development to be discharged to the Gun River.
    - Milestones:
        - Amend current storm water detention policy, in the Gun River Watershed, within 5 years.

Objective:

- Implement qualitative storm water design criteria.
    - Milestones:
        - Implement qualitative storm water design criteria within 5 years.

Objective:

- Promote conservation, farmland, and open space easements for infiltration and storm water storage areas to reduce the volume and velocity of storm runoff.
    - Milestones:
        - Identify areas where conservation, farmland, and open space easements for infiltration and storm water storage areas could be applied in the watershed within 5 years.

        - Secure easements in 25% of identified areas within 10 years.

Criteria:

- Availability of floodplain maps for Gun River Watershed.
- Participation in FEMA Floodplain Insurance Program.
- Changes in storm water detention policy and design criteria.
- Number of easements secured.

Monitoring:

- Allegan County LIS Annual Report.
- FEMA reports.
- Allegan Conservation District's annual report on the Gun River Watershed.
- Land Conservancy Annual Report.

Habitat Fragmentation

Milestones for achieving the goal of minimizing habitat fragmentation were based on the implementation of land use planning initiatives with the following objectives:

Objective:

- Promote conservation, farmland, and open space easements to protect habitat.
    - Milestones:
        - Identify areas where conservation, farmland, and open space easements for habitat protection could be applied in the watershed within 5 years.
        - Secure easements in 25% of identified areas within 10 years.

Criteria:

- Number of easements secured

Monitoring:

- Land Conservancy Annual Report.
- Allegan Conservation District's annual report on the Gun River Watershed.

Sediment, Hydrology, Hydrocarbons and Other Contaminants

Milestones for achieving the goal of reducing the potential for hydrocarbon contamination were based on the implementation of land use planning initiatives with the following objectives:

Objective:

- Improve storm water management techniques through ordinances or site design criteria to reduce runoff. Include innovative storm water management practices in county storm water rules and township land use ordinances.
    - Milestones:
        - Develop ordinance or criteria to improve storm water management within 5 years.
        - Integrate innovative storm water management practices in rules and ordinances with 5 years.

Objective:

- Implement low impact development strategies that encourage responsible land use planning, reduce the amount of impervious surfaces, promote infiltration to increase base flow, and maintain riparian corridors.
    - Milestones:
        - Develop low impact development strategies within 5 years.

Criteria:

Changes in storm water detention policy and design criteria
Impervious cover calculations

Monitoring:

- Allegan Conservation District's annual report on the Gun River Watershed.

Model Ordinances

The development of model ordinances will assist in meeting the objectives and milestones to determine if the pollutant reductions are being achieved over time and if substantial progress is being made toward attaining water quality standards. The following suggestions for model ordinances to be developed are prioritized in the order of the most desirable for addressing many of the water quality concerns:

- Greenbelts
- Storm water management
- Shoreline setbacks/riparian buffers
- Slope protection
- Wetland protection
- Open space preservation
- Farmland preservation
- High risk erosion areas
- Residential fertilizer use
- Yard waste disposal options
- Septic tank maintenance and operation
- Floodplain management

8.0.3 CRITERIA

The set of criteria developed to determine whether the WMP plan needs to be revised is based on the milestones, stated above for BMPs and Land Use Planning Initiatives, and the water quality changes. The WMP would need to be revised if the milestones are not being met in a timely manner or the goals seem unattainable, even with efficient implementation of the BMPs and Land Use Planning Initiatives.

The WMP should be revised if work toward achieving the following milestones during the implementation of the BMPs is not progressing in the specified timeframes:

- Exclude livestock from waterways, install windbreaks and 90% of filter strips and crossings, implement cover crop practices and 90% of conservation tillage practices, and complete 2 comprehensive nutrient management plans in Watershed within 5 years.

- Increase landowners participation in agricultural programs by 10% within 5 years.

- Conduct 20 Farm*A*Syst surveys within 5 years.

- Initiate sustainable monitoring program for high risk areas and volunteer monitoring program within 5 years.

- Provide education about turf management and distribute educational materials to all sites within 5 years.

- Initiate volunteer clean-ups to remove trash and debris within 5 years.

- Replace pipes and repairs banks within 5 years.

- Install all branch packing structures, all rock chute structures, all check inlet and stabilization structures; complete bank shaping, extended outlets, 90% of berm and tube structures, 50% of grassed waterways, and stabilize 90% of the outlets within 10 years.

- Remove all specified obstructions within 10 years.

- Improve pumps and install 10 solar powered pumps within 10 years.

- Propose strategy to control invasive species on Gun Lake within 10 years.

- Riparian buffers maintained on county drains within 10 years.

- Repair and/or replace all specified culverts and bridges within 20 years.

- Install all bioengineering and riprap within 20 years.

The WMP should be revised if work toward achieving the following milestones during the implementation of the Land Use Planning Initiatives is not progressing in the specified timeframes:

- Develop low impact development strategies, with strategies for residential areas based on “Landscaping for Water Quality”, within 5 years.

- Develop ordinance or criteria to improve storm water management, integrate innovative storm water management practices in rules and ordinances, implement qualitative storm water design criteria, and amend current storm water detention policy, in the Gun River Watershed, with 5 years.

- Identify areas where conservation, farmland, and open space easements for habitat protection, infiltration, and storm water storage areas could be applied in the watershed within 5 years.

- Secure open space and conservation easements in 25% of identified areas within 10 years.

- Work with Allegan County LIS to create floodplain map and enroll 2 Townships in the FEMA Flood Insurance Program within 5 years.

- Develop septic system inspection schedule, in cooperation with the Allegan County Health Department, within 5 years.

- Develop overlay maps within 5 years.

- Identify gaps or inconsistencies of wildlife strategies near surface waters within 5 years.

- Develop HEL plans with 5 landowners within 5 years.

8.0.4 MONITORING PLAN

The monitoring plan will assist in determining whether the evaluation criteria is being met for the implementation of the BMPs and Land Use Planning Initiatives. The monitoring includes local monitoring programs and will also coordinate with the State of Michigan's water quality monitoring efforts. Table 8.1 describes the components of the will be conducted:

Table 8.1 - Monitoring Plan

Monitoring Components	Units of Measurement	Measurable Goals	Schedule
Review of Drain Commissioners' maintenance schedules	Amount of obstructions removed or assessed	Reduction of drain maintenance projects	Annually
MDEQ biological surveys	Water Quality Rating (from SOS: Stream Quality Survey)	Increase rating of water quality	Every 5 years
USDA yearly status reviews	Number and location of BMPs implemented	Implement BMPs on all identified NPS sites of sediment and nutrient loading	Annually
Allegan Conservation District's annual report on the Gun Lake Watershed	Number and location of BMPs implemented	Implemented BMPs on all identified NPS sites of hydrocarbon contamination	Annually

Table 8.1 - Monitoring Plan

Monitoring Components	Units of Measurement	Measurable Goals	Schedule
Pollutant reduction calculations	Tons of sediment and pound of nutrients prevented from entering surface water	Reduce sediment by 10% of sediment loading per year Reduce nutrients by 10% of phosphorus loading and by 5% of nitrogen loading pre year	After each system of BMPs is implemented
Cost/benefit comparison of BMPs and pollutants reduced	Cost of BMP implementation and pollutant load reduction. Cost and health risk of eliminating source of *E. coli* and pollutant load reduction	Economic impact of pollutant load reduced outweighs cost of BMP implementation. Health risk reduction of *E. coli* reduced outweighs cost of BMP implementation	After each system of BMPs is implemented and all costs are incurred
Evaluations of volunteer clean-up days	Number of volunteers	Increase of volunteers at each clean-up day	After each clean-up day
Hydrologic Analysis	Peak flows shown on hydrographs	Reduce peak flows on hydrographs by limiting impervious cover, minimizing channelization of streams, and restoring wetlands	Every 2 years
Stream Inventory	Before and after photographs	Portfolio of photographs with supporting documentation	Annually
Water quality monitoring for *E. coli*	Number and location of sources eliminated	Eliminate discharge from all identified *E. coli* contributing sites and meet water quality standards for partial body contact recreation (1,000 count/100 ml) in all water bodies in the watershed and total body contact recreation (130 count/100 ml) in Gun Lake	To be determined
Annual drain inspections	Before and after photographs	Portfolio of photographs with supporting documentation	Annually
Natural features inventory on Gun Lake	Habitat evaluation. Populations of invasive species	Increase ratings for stream cover. Decrease observations of invasive species	Every 3 years
Land use and cover analysis	Amount of impervious cover by subwatershed	Changing development rules to limit amounts of impervious cover in developments	Every 5 years

Table 8.1 - Monitoring Plan

Monitoring Components	Units of Measurement	Measurable Goals	Schedule
Land Conservancy Annual Report	Acres of area to protect	Preservation tools in place to protect large tracts	Annually
Landscaping company surveys	Results of surveys	Increase of turf management requests	Every 2 years
Michigan Department of Natural Resources Annual Report	Habitat evaluation. Populations of invasive species	Increase ratings for stream cover. Decrease observations of invasive species	Annually
County Health Department Annual Report	Repairs or replacements of septic systems	All reported failures corrected	
Allegan County LIS Annual Report	Amount of impervious cover by subwatershed	Changing development rules to limit amounts of impervious cover in developments	Annually
FEMA reports	Participation in FEMA Flood Insurance Program	Increased participation in program	Annually

8.1 ADDITIONAL PLANNING AND IMPLEMENTATION PROJECT EVALUATION

An evaluation of the planning process was conducted during the development of the WMP to ensure that tasks were being completed, stakeholders were participating, and water quality issues were being addressed. These methods of evaluation, described in the following sections, will continue through the implementation phase of the project.

8.1.1 QUARTERLY REPORTS

The progress of the planning project was continually monitored by quarterly reports submitted to the MDEQ. These reports consisted of a narrative summary of accomplishments, a detailed budget explaining expenditures and local match, copies of any products and deliverables generated during that quarter, and an explanation of problems that caused a deviation from the work plan. These reports will be continued through the implementation phase of the project, if 319 funds are awarded.

8.1.2 STAKEHOLDER PARTICIPATION

The level of stakeholder participation in both the planning and implementation processes is key in determining the effectiveness of the Community Outreach Plan. Stakeholders have been included already in this project in the capacity of membership on the Steering Committee. Attendance and participation

throughout this process has been recorded and will be used to determine the number of committed members and the diversity of the stakeholders represented. In addition, public meetings have been held for stakeholder input and education. Attendance at these meetings has been recorded. The informational and educational measures taken to publicize the project during the planning phase will be reviewed for their effectiveness.

Stakeholder participation in educational workshops as well as the success in implementing the proposed BMPs will further measure the participation of stakeholders. The number of workshop participants should be compared to the number of public meeting participants during the planning phase to measure the change in interest.

8.1.3 WATER QUALITY MONITORING

A baseline survey of water quality was implemented in the planning phase of this project. The survey is an analysis of three components of the water; the physical, the chemical, and the biological.

- *Physical* - temperature, conductivity
- *Chemical* - pH, nitrogen, phosphorous, bio-chemical oxygen demand (BOD), dissolved oxygen
- *Biological* - macroinvertebrates

The physical and chemical monitoring occurred at five pre-designated sites at a monthly interval. The monitoring began in November 2001. This baseline evaluation of water quality was performed under the coordination of the Gun Lake Sewer and Water Authority staff with additional analysis being performed by Menasha Corporation.

A volunteer monitoring group of students will perform biological monitoring of macroinvertebrates. This will be coordinated by the Allegan County Math and Science Center.

At the conclusion of the implementation phase of this project, the water quality monitoring will continue through the Allegan County Math and Science Center program. The results can be used to track the improvements to water quality.

8.1.4 LESSONS LEARNED

Reporting on lessons learned is one of the most important sections in any project evaluation, because it takes into account not only the specific project's successes and shortfalls, but also indicates the improvements that could be made for future projects.

8.1.5 PARTNERS IN CONDUCTING EVALUATIONS

Each member of the various committees has shown interest in improving water quality in the Watershed, and has made a valuable contribution. Many of these members will continue to serve as vital players during the implementation phase. Strong interest has been shown in sustaining the Steering Committee, with commitments to meet at least quarterly. The Technical Committee will meet more often to oversee much of the structural and vegetative implementation process. The Information and Education Committee has proven to be a team which is effective in delivering messages to the community and fostering stewardship, a very important part of the Watershed project. While the committees provide much of the structure and organization of the Watershed project, it is what happens "on the ground" that ultimately matters most. All the committee members take what they have learned back to their organization, but many have more specific roles to play.

The ACD will take the lead in involving landowners in implementing BMPs on their land. Other partners will include the MDEQ for permitting and technical advising, as well as the NRCS for design assistance. The county drain commissioners will take the lead on improvements to designated county drains. The Southwest Michigan Land Conservancy, Ducks Unlimited, and other non-profit organizations will assist with conservation and preservation efforts.

The townships are responsible for enacting ordinances that help meet the goals of their community. Many ordinances and rules promote good practices. The townships must not only instruct their citizens, but must act in a manner that demonstrates their concern for resource protection.

The most important partners are the members of the Watershed community itself. Those who live, work, recreate, and simply enjoy its wildlife all shape the future of the Watershed. They are the stewards of the land, water, and air.

The educational community, consisting of the public school system and private schools are partners in educating both children and adults in the community. They are also proponents of responsible research and gaining understanding of the world around us. Public schools will be conducting water quality monitoring of the Watershed.

CHAPTER 9 - SUSTAINABILITY

Members of the Steering Committee provided information about many of the numerous organizations, programs, and ordinances that are working toward improving water quality in the greater Kalamazoo River Watershed. Building on these existing programs, the Steering Committee hopes to meet the goals of this Watershed Management Plan (WMP) and coordinate efforts with the Kalamazoo River Watershed project to accomplish the goals set forth in the Total Maximum Daily Load (TMDL) program. Long-term sustainability is possible for restoring this Watershed due to the high level of involvement in preserving and protecting the unique resource of Gun Lake and the Gun River.

The prevailing goal of this plan it to collaborate efforts of local stakeholders to bring about changes in activities that impact water quality and the way lakes and streams are managed. It will be important to identify and support current programs and organizations that have already gained momentum since the Kalamazoo RAP was created. Partnerships with these existing efforts in TMDL programs will be critical for the success of the management plan. Since Watershed goals can best be met with the coordination of water quality enhancement activities, it will be essential that citizens, business, and community organizations lead the effort.

9.0 ROLES AND RESPONSIBILITIES IN PROJECT IMPLEMENTATION

the Best Management Practices and information and education strategies will require a sustaining effort into the future to meet the goals of this WMP. A list of partners was generated during the Steering Committee meetings while discussing impairments to designated uses. To ensure that work is completed efficiently, tasks must be delgated to the appropriate agency or individuals that have the expertise and resources to accomplish assigned task. Tasks in the implementation plans have short-term, intermediate, and long-term goals and objectives. Therefore, this project is designed to be dynamic to change as new agendas arise or project goals change. Currently, three areas are included in this plan that need implementation strategies: BMPs, Information and Education, and Long-Term Project Goals.

9.0.1 BEST MANAGEMENT PRACTICES

The implementation of BMPs will undoubtedly be the most financially intensive task of the WMP. A sincere cooperative effort of the following groups and agencies will be required to obtain the necessary funds and resources to fulfill the goals and objectives of this project since they are a timescale of implementation over the next 20 years.

Drain Commissioners

The bulk of effort and responsibility for in-stream BMP implementation will fall to the Allegan County Drain Commissioner (ACDC). The Gun River has been straightened, deepened, and channelized since being designated a county drain in the early 1900s. Therefore, the ACDC will be responsible for any efforts to install BMPs that may affect the drainage of properties of the county drain network. This will include the planting of trees, plugging tiles to restore wetlands, buffer strips, bank shaping, and all erosion control structures. However, any practice that will require a budget greater than $2,500 per mile of stream, will require a special tax assessment that must be paid by the property owners. Therefore, public information and education strategies are critical to gain support for these projects that will mandate a tax assessment for beautification and restoration projects.

Conservation Districts

Conservation districts historically have been responsible for public outreach and technical assistance for projects and programs that protect soil and water quality. Their role in the WMP will be the same, only a higher level of involvement will be expected for efforts located inside the Watershed. Currently the Allegan Conservation District has played a critical role in the organization of a Steering Committee, the development of the I&E Strategy, and project evaluation.

The ACD has already built a strong relationship with landowners and agricultural producers in the watershed. The ACD will also be responsible for garnering support for new projects that may require assessment taxes or changes in the publics' habits. This project's sustainability will depend on the Conservation District's resources to continue education efforts and to supply technical assistance for BMP implementation to ensure the momentum of the project.

Road Commissions

At this time, a total of 41 road crossings in the Watershed have been surveyed. Of these sites, 31 are in need of repair or replacement, and more road crossings still need to be inventoried. Cooperation with the Allegan County Road Commission (ACRC) is vital to achieve the goals of the Watershed plan. The hydrologic and hydraulic studies have determined that a number of culverts, either blocked or inadequately sized, are causing flooding and erosion. Consequently the ACRC will be responsible for the repair or replacement of these culverts or bridges. The ACD will work with the ACRC to see that these changes are in line with the project goals and objectives and are accomplished with the smallest impact to water quality.

United States Department of Agriculture

The USDA Service Center houses the Natural Resource Conservation Service (NRCS) and the Farm Service Agency (FSA). Programs offered by the NRCS and FSA are listed below in Section 9.3. The WMP depends upon USDA programs to provide technical and financial assistance to landowners and farmers who wish to develop and implement practices that will promote water quality and limit soil erosion. Given that one of the WMP's main goals is to reduce sediment and nutrients entering the Gun River, cooperation with the agricultural areas are very important to the successful completion of the plan.

Michigan State University Extension (MSU Extension)

Staff at the MSU Extension have resources to perform a variety of soil tests. These tests have been readily used by farmers to recommend proper amounts of fertilizers. Free tests are also done by fertilizer suppliers. The agriculture stakeholders suggested that MSU Extension educate fertilizer dealers about interpreting their own results and making recommendations that reflect crop nutrient management plans that coincide with the TMDL goals.

Enforcing Agencies for Soil Erosion and Sedimentation Control

To ensure that managerial BMPs are being followed, construction site inspectors must have a working knowledge of any changes in township ordinances that will arise after the implementation of this WMP. Enforcing agents must be able to explain the reasons for code changes and alternatives to obsolete site management practices that endangered water quality.

Landowners

Many of sites for BMP implementation are on private property. Since implementation of these structural or vegetative BMPs is on a volunteer basis, the success will chiefly rely on the public information and education strategy.

Conservation Organizations

Conservation organizations already have access to a great number of enthusiastic men and women ready to volunteer time to the enhancement of outdoor recreational activities. One example of this enthusiasm comes from the Muskegon River Watershed Project. Trout Unlimited had a volunteer work day planned for a Saturday morning where they expected roughly 20 individuals to attend. However, the watershed coordinators found themselves running for extra hotdogs three times for the almost 200 people that arrived over the course of the day. If the Watershed has this kind of public outpouring, a volunteer stream restoration day would have a tremendous affect on the quality of recreation in the Gun River.

9.0.2 INFORMATION AND EDUCATION

Conservation Districts

As stated earlier, the Conservation District's essential role in the WMP will be public information and education. To ensure the long-term sustainability of the project, the public must be involved and supportive of its goals and objectives. The Conservation District plans to maintain awareness and involvement of stakeholders in the Watershed project through a variety of outreach programs detailed in Chapter 6. Key roles played by the Conservation District will be the production of newsletters and informational brochures. These types of outreach programs increase the visibility of the Watershed and facilitate the public's recognition that the Gun River is a great resource for their communities. In addition to printed materials, the conservation district staff will be available for technical guidance for implementing erosion and sedimentation control structures and practices.

United States Department of Agriculture

The USDA has offices in Hastings and Allegan for servicing their respective counties. For anyone wishing to enroll property into conservation management programs, they must sign up at their county office. Landowners should be encouraged to visit, and the USDA offices should likewise use their resources to inform and educate the public about services that are available through the NRCS and the FSA. The USDA also offers a plethora of agriculture related information media including brochures, newsletters, and displays for a reduced cost for its clients.

MSU Extension

As an educational facility, the MSU Extension should play an active role in public education. The extension has highly qualified field personnel that can perform soil testing and recommend the proper rate applications of fertilizers and herbicides. The agriculture stakeholders of the Kalamazoo TMDL Implementation Plan have requested that the MSU Extension educate fertilizer suppliers about the TMDL and how to properly recommend phosphorus application rates. In addition to field services, the MSU Extension has an online directory of publications about land stewardship practices to protect the environment and productivity of the land.

Publications: Gun Laker Magazine and Wayland Globe

The Gun Laker Magazine and Wayland Globe are both highly visible publications in the Watershed. Both have already run articles about the current WMP, and it is hoped that they will continue their support for this project. Agricultural publications could also be solicited for support in reducing phosphorus and sediment inputs from field runoff or wind erosion.

Groundwater Stewardship Program: Farm*A*Syst, Home*A*Syst, and Field*A*Syst

The MDA administers a program for farmers that provides technical support in reducing contaminants and improving groundwater usage efficiency. The program has now spread to surface waters in groundwater protection zones and provides up to 90% of the implementation cost of agricultural BMPs. Homeowners and farmers both can enlist in this voluntary and confidential program that helps identify risks to groundwater safety in the home or on the farm.

Lake Associations and Boards

Lake associations and lake boards are often the only link between township ordinances and temporary lake residents. Many of the riparian landowners and renters do not have knowledge of local ordinances or any projects, like this WMP, that are occurring when they are away. For that reason, lake associations or boards must take a proactive approach to community riparian involvement. Associations need to distribute informative literature, host educational meetings that are interesting to the greater public, and become active themselves in this Watershed project.

9.0.3 LONG-TERM PROJECT GOALS

Changing management strategies requires a very long review process, public approval, and implementation time for restructuring and supervising changes. Consequently, changing township ordinances and land use planning has been identified as a long-term project goal.

Townships and Planning Commissions

A formal review of existing ordinances and how they fit into the management plan is needed before any planning can proceed. Once the current policies have been assessed, the community needs can be identified. At this point all stakeholders need to be identified and brought into the planning process. All involved must state their needs and how they will fit into the TMDL and WMP. The goal is that a comprehensive model ordinance will be developed for townships in the Watershed to use. This ordinance should continue to use this plan and the TMDL Implementation Plan as a tool for land use planning that contains specifications for storm water, acceptable land uses, conservation measures, and other strategies to preserve open land and water quality.

It will also be the townships' responsibility to sustain the momentum of community support for this project. They can do this by using the Gun River as the feature for their community that deserves recognition. This can be accomplished through hosting watershed celebrations or by designating sections of the riparian corridor as township or county parks.

Michigan Township Services

Michigan Townships Services is a private corporation that is contracted by the County Enforcing Agency to inspect soil erosion and sedimentation control permitees. Their services provide an excellent means of information gathering for townships about the status of project implementation and compliance. Presentations at township committee meetings could offer needed information to officials about additional needs for control of sediment.

9.1 ANALYSIS OF OTHER PROJECTS AND PROGRAMS

A number of ongoing projects in the Kalamazoo River Watershed have surfaced in response to the implementation of the Kalamazoo RAP. Table 9.1 shows a number the water quality protection and enhancement projects in the basin. There are many lessons to learn by studying the successes and failures of the ongoing projects in the Watershed. Some of these projects are summarized below.

Table No. 9.1 - Water Quality Projects and Programs Pertaining to the Gun River Watershed

Project or Program	Sponsoring Organizations	Primary Purpose	Geographic Scope	Time Frame
Kalamazoo River Watershed Council		Remedial Action Plan, education, communication, advocacy, technical assistance	Kalamazoo River Watershed	Ongoing
Watershed Information Management Project	Western Michigan University GEM, City of Kalamazoo, Kalamazoo County Environmental Health	Set up regional center to collect, maintain, and disseminate environmental quality data	Regional	Ongoing
Wellhead Protection Programs	City of Otsego	Protect groundwater	City of Otsego	Ongoing
GIS Watershed Atlases	Western Michigan University GIS Research Center	Create GIS atlas of land use, soils, wetlands, etc. for land use planning and natural resources protection	Kalamazoo River Watershed in Allegan, Barry, and Kalamazoo Counties	Ongoing
Farm Bill Programs for natural resource protection on agricultural lands	Natural Resource Conservation Service and Conservation Districts	Conservation planning and implementation on agricultural lands		
Household Hazardous Waste Collection	Allegan County Health Department	Collection and disposal of household hazardous waste	Most areas of Allegan County	Ongoing
Michigan State University Extension programs	Michigan State University	Education, technical assistance for agriculture, and groundwater protection	Michigan	Ongoing
Michigan Department of Environmental Quality NPS Program	Michigan Department of Environmental Quality	Technical assistance, watershed planning assistance, regulatory assistance, and grant funding	Michigan	Ongoing
Michigan Groundwater Stewardship Program	Michigan Department of Agriculture, Michigan State University	Farm*A*Syst, Field*A*Syst, closing abandoned wells, emergency plans/tubes, BMP cost-share	Allegan and Barry Counties	Ongoing
NPDES Program	Michigan Department of Environmental Quality	Permits, regulatory framework for some point source discharges	Michigan	Ongoing
Local Government development permitting	Local units of government	Land use decisions and regulations, site plan reviews	Cities and townships	Ongoing
Part 91 Program, (NREPA, PA 451, 1994 as amended)	Counties, cities, or public agencies as enforcing agents	Soil erosion control from construction activities	Michigan	Ongoing

9.1.1 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT PROGRAM

Created in the Clean Water Act of 1972, the National Pollutant Discharge Elimination System (NPDES) was designed to work with industry to implement the best available technology into wastewater treatment facilities. Industrial or commercial operations that discharge any pollutants to a water body are required to obtain a permit from the MDEQ. The permit is typically active for 5 years and specifies the treatment levels necessary for the permitee. Once the permit has expired, the industrial standards are reviewed and a new permit is issued under the stipulation that the permits specified technologies are implemented into the water treatment systems. Currently, one NPDES permit has been issued for industrial discharge and one for storm water discharge in the Watershed.

9.1.2 MICHIGAN GROUNDWATER STEWARDSHIP PROGRAM

Farm*A*Syst is a voluntary and confidential program that works with farmers to identify potential risks of groundwater contamination on their farm. A groundwater technician completes a worksheet with the farmer and helps identify ways to reduce the risk of groundwater contamination from such things as fertilizers, animal wastes, pesticides, petroleum products, and other chemicals. An additional project is the creation of emergency plans, which map the farm, including storage facilities and escape routes. These are then placed in a weatherproof tube on a telephone pole in front of the farm. In the event of a fire, these plans will be used by firefighters to locate dangerous chemicals.

Field*A*Syst is another voluntary and confidential program offered to farmers. Technical assistance for soil testing and agricultural BMPs is provided free of charge to all enrolled in the program. Cost sharing is available for demonstration projects.

The **Abandoned Well Closures** program identifies areas on farms that are a groundwater contamination threat. Abandoned well heads may become infiltration points for nitrogen and pesticide to enter groundwater. Those participating in the program can obtain free literature, technical assistance, and cost sharing up to 90% for the closure of abandoned wells.

9.1.3 GENERALLY ACCEPTED AGRICULTURE MANAGEMENT PRACTICES

In July 2002, the Generally Accepted Agriculture Management Practices (GAAMPS) were finalized. Any farm operation that abides by these GAAMPS will not be found as a public nuisance. The design of this bill (PA 93) was meant to protect farmers from nuisance lawsuits. Large scale farm operations should be MDA certified as compliant for this litigation protection. The added benefit to the Watershed is that farmers are given this incentive to operate in an environmentally sound manner.

9.1.4 PUBLIC ACT 116

Public Act 116 (PA 116) is a state public act which gives tax incentives for purchasing development rights. In order for land to qualify, it must be suitable for farming, be adjacent to protected farmland, or be in an area which local government wishes to protect as farmland. Local units of government can submit an application for a grant to pay for the conservation easement.

9.1.5 DRAIN COMMISSIONER

The county drain commissioners assist with water activities that are associated with designated drains. They are responsible for drain improvements and keeping the integrity and appropriate function of the drains intact. The Gun River and many of its tributaries are designated county drains, therefore the ACDC should be an included partner in any in-stream projects.

9.1.6 DEPARTMENTS OF STATE AND FEDERAL GOVERNMENT

The following agencies provide technical and financial assistance to many projects. Often projects must meet certain rules or need specific permits. The following departments should be contacted if questions arise about permit requirements.

- United States Department of Agriculture - Farm Service Agency (FSA)
- United States Department of Agriculture - Natural Resource Conservation Service (NRCS)
- Michigan Department of Transportation (MDOT)
- Michigan Department of Agriculture (MDA)
- Michigan Department of Environmental Quality (MDEQ)
- Michigan Department Natural Resources (MDNR)

9.1.7 GUN PLAIN CHARTER TOWNSHIP PLANNING ORDINANCE

Section 12.1 of the Gun Plain Charter Township Planning Ordinance proposes a "Greenbelt Overlay District" to the Gun River and Gun Lake areas inside Gun Plain Township. Although the ordinance has not passed public approval, the ideas specified therein are good models for other townships to consider. The Greenbelt Overlay recognizes areas within the township's riparian zones that need special consideration for zoning requirements. Some example proposals are listed below:

- Native protective strip of 75 feet for watercourses and 25 feet for lakes.
- No dwelling or structure on lands subject to flooding.
- No storage of hazardous substances within 150 feet of high water line.
- Septic system setbacks of 150 from high water mark.

9.1.8 FRIENDS OF THE GUN RIVER

Currently, this group has no formal statement of its goal and objectives, however, a growing movement in the Watershed is expressing a strong desire to move this group into the formalization stage. Examples of this group's accomplishments are two highly productive river clean-up projects. Other goals are newsletters, committee meetings, further clean-up projects, and a formalized members list.

9.2 FUNDING AND RESOURCE OPPORTUNITIES

At this time, funding for the State's Clean Michigan Initiative (CMI) has been delayed. To best ensure the sustainability of this project, it is important to diversify funding options. Below are many examples of funding and resource sources that the Gun River is eligible to receive.

9.2.1 SECTION 319 IMPLEMENTATION FUND (319)

Section 319 Implementation Funds derive their name from Section 319 of the Federal Clean Water Act of 1972. Section 319 funds are a component for implementing a WMP that supplies funding for projects that are in the planning stage or are in need of monies to support non-physical improvements. Since 319 funds are granted by the federal government, they have been more stable than the CMI program. The WMP will still rely on 319 funds for part of the budget for I&E programs, site planning, township ordinance changes, and implementing managerial BMPs.

9.2.2 EPA 5-STAR GRANT

The EPA 5-Star Grant involves 5 entities; students, conservation corps, corporations, landowners, and government agencies, who provide environmental education through projects that restore streambanks and wetlands. The program provides challenge grants, technical support, and opportunities for information exchange to enable community-based restoration projects. The grants are typically small, around $10,000, but they are accessible to the general public and are flexible to meet the grantees needs. In most cases, a school would be able to get this grant for environmental education programs. These programs are very important for project sustainability since they are creating stewardship in the communities' young people at an impressionable age.

9.2.3 MICHIGAN VOLUNTEER MONITORING GRANTS

Another source for the evaluation of the project could be the Michigan Volunteer Monitoring Grant made available by the MDEQ. These grants supply watershed committees or local governments with matching funds for the purchase and maintenance of stream monitoring programs. Training time should also be committed for background information and quality assurance guidelines for sampling protocol.

9.2.4 UNITED STATES FISH AND WILDLIFE SERVICE (USFWS)

The Watershed is home to the rare and elusive king rail, a migratory wetland bird species. This bird and many other species depend on the Watershed for wetland areas for habitat, mating grounds, and foraging areas. As wetlands disappear, so do many of the related species that cannot adapt to life outside the wetland. The USFWS supports large and small wetland projects and the Gun River may be given preferential treatment since it is home to the king rail. Grants are 1:1 matching funds up to 1 million dollars for wetland and bird habitat restoration projects.

9.2.5 THE GREAT LAKES COMMISSION - SEDIMENT AND EROSION CONTROL PROJECT GRANTS

The Great Lakes Commission in cooperation with the EPA Region V and the NRCS are providing small sedimentation and erosion control grants to local authorities in the Great Lakes Areas of Concern. The Kalamazoo River Watershed, which includes the Gun River is one of Michigan's 43 Areas of Concern and is eligible for one of these grants. Eligible projects must be specific with a clear goal that can have evaluated results for the reduction of sediment and erosion. The Great Lakes Commission publishes reports in an annual newsletter called *Keeping It On the Land.*

9.2.6 NATURAL RESOURCES CONSERVATION SERVICE FARM BILL PROGRAMS

Wetland Reserve Program

The Wetland Reserve Program is run by the USDA. It provides easements for restoring wetlands in agricultural land. Financial incentives, free technical support, and cost sharing are provided. The retirement of the land must be for a minimum of 10 years, but 30-year and permanent easements are also offered in which the USDA pays a much greater amount of the cost of restoration and price of the land. The landowner controls access to the land and may use it for recreational activities such as hunting and fishing. Other options may be negotiated in the contract.

Conservation Reserve Program

The CRP was created in 1985 as part of the Food Security Act. The producer enters into a long-term contract. In the CRP, the land is set aside and a permanent cover is established. In return, the farmer receives and annual per acre rent and up to half the cost of establishing cover on land that has recently been farmed and is highly erodible or environmentally sensitive. Additional acts in 1990 and 1996 have allowed continued enrollment and expanded the scope from reducing soil erosion to include habitat conservation. Participants may sign up at any time to perform the following practices on their land. A typical agricultural land rent in southwest Lower Michigan is around $35 per acre. The CRP program gives an added 20% bonus for land used in any of the below measures:

- Filter Strips
- Riparian Buffers
- Shelterbelts, Field Windbreaks, and Living Snow Fences
- Grass Waterways
- Shallow Water Areas for Wildlife
- Salt-Tolerant Vegetation
- Certain Approved Public Wellhead Protection Areas

Today, the Environmental Benefits Index (EBI) is used to prioritize land offered for enrollment. Scores are based on a cost factor, plus six environmental factors, as follows.

- Wildlife
- Water Quality
- Erosion
- Enduring Benefits
- Air Quality Benefits from Reduced Wind Erosion
- State or National Conservation Priority Areas (CPAs)

The Great Lakes, along with Long Island Sound, the Chesapeake Bay, the Longleaf Pine region, and the Prairie Pothole region comprise the national CPAs.

Environmental Quality Incentives Program (EQIP)

Another provision funded by USDA and created in the Food Security Act of 1985 is the EQIP. The voluntary EQIP makes enrolled land eligible for flexible grants for conservation practices. EQIP may pay up to 75% of the cost of conservation practice implementation. Some practices eligible for funding are:

- Comprehensive nutrient management plans
- Irrigation improvements
- Conversion to less water intensive crops
- Improved water storage measures
- Groundwater recharge measures or banking
- Other programs that result in a net savings in groundwater or surface water resources

Wildlife Habitat Incentives Program (WHIP)

WHIP is another voluntary conservation program that encourages the protection or creation of high quality wildlife habitat that supports populations of locally significant wildlife. The USDA provides landowners with technical support and financial assistance to develop habitat areas on their property. Interested landowners must contact the state conservationist for enrollment into the WHIP. If accepted, the NRCS and FSA will work with the landowner to develop a 5- to 10-year cost-share plan.

Farmland Protection Program (FPP)

The FPP, conducted by the NRCS and FSA is a voluntary program that helps farmers keep their land in agriculture. The program funds state and local governments, conservancies, and other non-government organizations to purchase conservation easements. The agreements are typically 30 years and priority is given to lands with perpetual easements. Organizations or governments that are eligible for funding can receive 50% of the fair market value for the property in question. Eligibility requirements are:

- Contains prime, unique, or other productive soil or historical or archaeological resources;
- Be included in a pending offer from a state, tribal, or local government or non-governmental organization's farmland protection program;
- Be privately owned;
- Be covered by a conservation plan for any highly erodible land;
- Be large enough to sustain agricultural production;
- Be able to be converted to non-agricultural uses in the existing deed;
- Be accessible to markets for what the land produces; and
- Be surrounded by parcels of land that can support long-term agricultural production.

9.2.7 OTHER SOURCES OF FUNDING AND RESOURCES

Nature Conservancy

The Nature Conservancy is a well known and very selective conservation organization. They identify exemplary sections of land from across the world that are unique and threatened. They are also an advocacy group and promote educational activities and projects which help conserve unique natural heritage sites. To learn more about the Nature Conservancy, go to http://nature.org/.

Student Volunteer Stream Monitoring

The Allegan County Math and Science Center currently is operating a student stream monitoring program for Allegan and Wayland Public Schools. Grants are available through 319 and CMI for funding the programs implementation. Student groups are sustainable even if grant monies are no longer available.

Michigan Audubon Society

The Audubon Society is an organization that has been working to conserve habitats in the United States for over 100 years. John James Audubon described and painted birds. The Michigan Audubon Society is Michigan's oldest conservation organization, conceived in 1904. They have sanctuaries and nature centers, as well as other outreach and educational material that is available throughout the state. See their website for more information: http://www.michiganaudubon.org/index.html.

Michigan United Conservation Clubs (MUCC)

The MUCC has a membership that is interested in acting locally to conserve natural resources and use them wisely. They are an advocacy group and lobby in the State of Michigan. More information is available at http://www.mucc.org/.

American Farmland Trust (AFT)

The AFT works toward sustainable agriculture by working with communities and landowners. More information is available at http://www.farmland.org/.

Innovative Farmers

The Innovative Farmers is a group of agricultural producers interested in new sustainable practices and techniques which are environmentally and financially sound. They work as a community, sharing resources, to develop demonstration projects that use innovative techniques. It is farmer-based research that can be shared with other Innovative Farmers groups and applied in other areas.

Michigan State University Extension (MSUE)

MSUE utilizes the resources of Michigan State University and works on community outreach, especially with agriculture and families. MSUE offers a wide variety of technical assistance and employs individuals with high levels of expertise in their area of concentration to meet specific needs of producers. They are also involved with research to better the services and technology available.

4-H

The 4-H club is the youth education branch of the Cooperative Extension Service, and in Michigan, 4-H is associated with MSUE.

Future Farmers of America (FFA)

The FFA involves youth in farming activities and teaches them skills they will need to be farmers, including soil identification and livestock care. There is an opportunity to involve them in implementation of BMPs on farms in the Watershed.

Boy and Girl Scouts

The Boy Scouts of America and the Girl Scouts of the USA involve many boys and girls, respectively, in the Watershed with personal growth and community stewardship. Boy and Girl Scouts work on community and natural resource projects. They learn through service and the collaboration of the Watershed project and these groups would have mutual benefits.

The highest honor a Boy Scout can earn is becoming an Eagle Scout. Strict requirements must be met for this prestigious award, one of which is to design and implement a project that benefits the community. Many Eagle Scouts do their projects in association with natural resource awareness, such as building boardwalks at wetlands or interpretive trails at nature centers. Many opportunities exist in the Watershed project to work with an Eagle Scout candidate to help him achieve his goals and improve the Watershed.

CHAPTER 10 - RESOURCE LIBRARY

Many resources were available for use in the creation of this document. A collection of the materials and literature pertaining to the Gun River Watershed is housed at the ACD and is available for public use. The following list includes the documents currently in the resource library. The list will be periodically updated with additions:

Federal, State, and Municipal Manuals and Handbooks

FSA. The 13th Sign-Up. 1994. http://www.fsa.usda.gov/dafp/cepd/12crplogo/page29.htm

Hardwood, Richard. 1993. *Improving Nitrogen Utilization with Rotation and Cover Crops.* SARE, E2692. 1993. http://www.msue.msu.edu/misanet/papers/E2692_sare08-9.htm

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USDA, Soil Conservation Service. 1990. *Soil Survey of Barry County, Michigan.* Lansing, Michigan.

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Reports and Study Literature

Duffy, Joan. 1991. *Gun Lake*. Michigan Department of Natural Resources, Status of the Fishery Resource Report 1991-2. http://www.dnr.state.mi.us/www/ifr/ifrlibra/Status/Waterbody/91-2.htm

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Keto, Dan. 2001. Species Inventory, Gun River between 110th and 107th Avenues.

Krueger, Thomas J. 1997. *Aquatic Survey of Gun Lake, Barry and Allegan Counties, Michigan*, AAT Labs, Inc.

Non-Point Source Modeling of Phosphorus Loads in the Kalamazoo River/Lake Allegan Watershed for a TMDL. http://www.kalamazooriver.net/tmdl/docs/docs.htm

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Warbach, John, Ph. D. and Mark A. Wyckoff, AICP. 1995. *Growth Management Tools & Techniques.* Publication of the Michigan Coastal Management Program, Michigan Department of Natural Resources.

Wesley, Jay K. 2000. *Fish Lake*. Michigan Department of Natural Resources, Status of the Fishery Resource Report 2000-13, (Barry County T2N, R10W, Sec. 16, 21). http://www.dnr.state.mi.us/www/ifr/ifrlibra/Status/waterbody/00-13.htm

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Kalamazoo River/Lake Allegan TMDL Implementation Committee. 2002. *Water Quality Improvement (Implementation) Plan for the Kalamazoo River Watershed and Lake Allegan Through a Phosphorus Total Maximum Daily Load (TMDL) Process.* July 28, 2002. 98 pp.

Kalamazoo River Watershed Council. 1998. *The Kalamazoo River: Beauty and the Beast.* Remedial and Preventive Action Plan for the Kalamazoo River AOC.

Kieser & Associates.2001 *Non-Point Source Modeling of Phosphorus Loads in the Kalamazoo River/Lake Allegan Watershed for Total Maximum Daily Load.* Prepared for the Kalamazoo Conservation District, April 2001. 59 pp.

Keto, Dan. 2001. Species Inventory, Gun River between 110th and 107th Avenues.

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Michigan Department of Natural Resources, Surface Water Quality Division, 1990. *A Biological Survey of the Gun River, Allegan County, Michigan, July 26, 1989.* MI/DNR/SWQ-90/136.

Michigan Department of Natural Resources. 2000. *Trout Survey, Gun River, September 13, 2000.*

Michigan State University's *"Revised Universal Soil Loss Equation (RUSLE) Online Soil Erosion Assessment Tool"* (www.iwr.msu.edu/rusle/soil_loss.htm)

Non-Point Source Modeling of Phosphorus Loads in the Kalamazoo River/Lake Allegan Watershed for a TMDL, 2000. http://www.kalamazooriver.net/tmdl/docs/docs.htm

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www.farmland.org

www.kalamazooriver.net

www.kalamazooriver.net/cgi/ps_vz/intro.cgi

www.michiganaudubon.org

www.msue.msu.edu/misanet/papers

www.mucc.org

www.naturenearby.org

GLOSSARY

Area of Concern - one of the 42 regions designated by the International Joint Commission which adversely contributes to the Great Lakes or St. Lawrence River.

Anthropogenic - caused or produced by humans.

Attenuation (hydrograph) - the reduction of the slope of a hydrograph, whereby the flow is extended over a longer period of time.

Base Flow - the part of the stream flow that is not due to direct runoff from precipitation; it is usually supported by water draining from natural storage in groundwater bodies, lakes, or wetlands.

Benthic - referring to the stream or lake bottom.

Best Management Practice (BMP) - structural devices or nonstructural practices that are designed to prevent pollutants from entering storm water flows, to direct the flow of storm water, or to treat polluted storm water flows.

Clean Michigan Initiative (CMI) - a bond approved by Michigan voters in 1998, which designates $165 million for structural and managerial enhancements which improve water quality in Michigan.

Clean Water Act 303(d) Non-attainment List - a list that must be produced by each state every 2 years, of waterbodies that do not meet water quality standards.

Coldwater Fishery - summer temperatures must not exceed that which are able to sustain trout, with optimum temperatures between 50°F and 60°F for coldwater and 60° F and 70°F for coolwater fisheries.

Confluence - the point at which two or more watercourses intersect.

Conservation - the use of a resource within the limits, which are set.

Critical Area - that part of the watershed that is contributing or has the potential to contribute a majority of the pollutants and is having the most significant impacts on the waterbody.

Culvert - a covered channel or a large diameter pipe that directs water flow below the ground level.

Designated Use - one of the seven uses designated by the State of Michigan which every surface water in Michigan must meet.

Desired Use - uses that are determined important by local stakeholders that do not fall into the categories designated by the State of Michigan.

Detention Basin - a storm water structure in which part of the runoff is detained, and the remainder is contained in a permanent pool.

Discharge - a release or flow of storm water or surface water, usually expressed as cubic feet per second.

Dissolved Oxygen - the amount of gaseous oxygen (O_2) dissolved in an aqueous solution (water).

Drain - a reach which has been placed under the jurisdiction of a county drain commissioner.

E. coli (Escherichia coli) - bacterium used as an indicator of the presence of waste from humans and other warm-blooded animals.

Eutrophication - the process of enrichment of waterbodies by nutrients, which may lead to increased growth of algae or rooted plants. Process can be natural or accelerated by human activity (cultural eutrophication).

Filter Strip - a grassed area adjacent to a waterbody which is used to filter NPS pollution.

Flashy Flow - a river or stream which reacts dramatically to storm events, producing high fast flows during and immediately following a storm event.

Floodplain - the area in a river valley covered with soil deposited by floods.

GIS - a system that analyzes and models data in a spatial context and displays digitally recreated map layers.

Geotextile - fabric which is used in soil erosion control for the purpose of retaining soil until vegetation is established.

Glaciolacustrine - of an ancient lakebed formed by glaciers, having fine grained texture sediment which results from ground debris in glacial meltwater.

Groundwater - the subsurface water supply in the saturated zone below the water table.

Gully Erosion - severe erosion in which trenches are cut to a depth greater than 30 centimeters (1 foot).

Headwaters - the origin and upper reaches of a river or stream.

Hydraulic Model - prediction of the behavior of flows within a channel.

Hydric Soil - a wetland soil, characterized by high moisture, low oxygen, and low redox potential, the ability to exchange electrons.

Hydrograph - a chart which shows the relationship between flow and time, used to assess the behavior of the watershed.

Hydrologic Model - prediction of the behavior of overland flows and their reaction to storm events.

Hydrologic soil group - a classification of the infiltration rates of soils types.

Imperviousness - the amount of surfaces through which little or no water will move. Impervious areas include paved parking lots and roof tops.

Infiltration - the penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Land Cover - classifications based on aerial imagery which shows the type of vegetation and structures, including classification of forest types and other vegetative classifications.

Land Use - classification of the practices which occur on the land, such as residential or recreational park.

Macroinvertebrate - animals without vertebrae that are large enough to be seen without a microscope, such as many insect larvae and crawfish.

Nitrogen - a colorless, odorless, gaseous element that constitutes about four-fifths of the volume of the atmosphere and is present in combined forms in animal and vegetable tissues, especially in proteins. Used chiefly in the manufacture of ammonia, nitric acid, cyanide, explosives, fertilizers, and dyes (as a cooling agent). Also an essential nutrient needed by healthy plants. An element that at certain levels can cause excessive algae and aquatic weed growth.

NPS Pollution - pollution that is not traceable to one particular source and is occurring at locations scattered throughout the drainage basin; typical sources include erosion, agricultural activities, and urban runoff.

Open Space - agricultural land, greenbelt, parks, golf courses, and other areas in which human structures are minimal or nonexistent.

Phosphorus - a necessary element for bones, nerves, and embryos; its compounds are used in matches and phosphate fertilizers. Also, an essential nutrient needed by healthy plants. An element that at certain levels can cause excessive algae and aquatic weed growth.

Point Source - any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant - any substance of such character and in such quantities that when it reaches a body of water, oil, or air, it contributes to the degradation or impairment of its usefulness or renders it offensive.

Preservation - restrictions on all consumptive use of a resource.

Reach - a segment of a river or stream. The EPA's Reach File Version 3.0 lists over 3.2 million reaches across the United States and its territories. Each reach is given an identifying number according to its location and watershed.

Retention - capturing storm water and slowly releasing it through infiltration into the ground.

Rill Erosion - erosion consisting of a series of small channels eroded into the soil by surface runoff.

Riprap - a permanent cover of rock used to stabilize streambanks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows.

Riparian - shore area of a lake or bank of a river or stream.

Road/Stream Crossing - where a road crosses over a stream, normally a bridge or a culvert.

Sediment - soil that is transported by air and water and deposited on the stream bottom.

Stakeholder - any organization, governmental entity, or individual that has a stake in or may be affected by a given approach to environmental regulation, pollution prevention, or energy conservation.

Storm Water Runoff - surface water movement resulting from a storm event, snow melt runoff, or surface runoff and drainage.

Subcatchment - smaller drainage area within a watershed or river/stream basin.

Sustainable - the principle that the needs of the present should be met without compromising the ability of future generations to meet their own needs.

Tile - a semi pervious pipe that facilitates drainage from the soil to surface waters.

Toe of Streambank - the bottom of the streambank where the bank meets the streambed.

Warmwater Fishery - waterbodies able to maintain fish populations of bass, pike, walleye, or panfish.

Waters of the State - a water body under jurisdiction of the state, normally defined as having the ability to float a log.

Watershed - the geographical region within which water drains into a particular river, stream, or body of water. Watershed boundaries are defined by the ridges separating watersheds.